Appendix D1

VISSIM Microscopic Analysis of US 281 from Loop 1604 to Borgfeld Drive

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1.1 INTRODUCTION

Jacobs Engineering Group Inc. was retained by the Alamo Regional Mobility Authority (Alamo RMA) to prepare a Final Environmental Impact Statement (EIS) for the US 281 Corridor Project with project limits of Loop 1604 and Borgfeld Drive. The purpose of this memorandum is to provide results of the traffic operations analyses performed for the Preferred Expressway Alternative along this corridor. This memorandum summarizes the assumptions, methodology and results related to the travel demand modeling, data collection (including travel time runs), development of corridor traffic projections, operational analysis (using VISSIM).

The full description of the Preferred Expressway Alternative is included in the Final EIS, and includes the construction of:

- Three expressway lanes in each direction between Loop 1604 and Stone Oak Parkway:
    - Two (2) non-tolled general purpose lanes with an auxiliary lane and
    - One (1) managed (tolled) lane, and
- Three expressway lanes (managed) in each direction between Stone Oak Parkway and the Borgfeld Drive.

1.2 BACKGROUND

As part of the Draft EIS, Jacobs performed screening analyses of the reasonable alternatives using the Alamo Area Metropolitan Planning Organization, formerly San Antonio – Bexar County Metropolitan Planning Organization (MPO) 2035 travel demand model. The Draft EIS alternative screening included a 2035-No Build Alternative, 2035-Expressway Alternative, and a 2035-Elevated Expressway Alternative. **Appendix D2** contains the technical report on the application of the MPO's 2035 travel demand model.

For the Final EIS, Jacobs was tasked with evaluating the traffic operational analysis of the Preferred Expressway Alternative in the opening year (2018), and the design year (2038). There was no traffic operational evaluation of the existing conditions or the No-Build Alternative.

There are three main differences between the Draft EIS travel demand modeling and the Final EIS traffic operational analysis.

- Method of Developing Traffic Projections: Travel demand modeling uses population and employment statistics (organized by market segment) to determine the projected traffic volumes on the regional roadway network using a four-step process (trip generation, trip distribution, modal split, and traffic assignment), and uses traffic counts to validate the current year model volumes. Traffic operational analysis begins with traffic projections developed from historical traffic counts, new traffic counts, and travel demand model runs to define detailed projected traffic volumes using linear growth rates.

- Analysis Capabilities: Travel demand modeling focuses of unconstrained demand over a regional roadway network, with very limited operational analysis capabilities. Traffic operational analysis uses traffic projections specifically developed for a corridor and roadway configuration to determine the capacity, levels of delay and levels of congestion of the roadway elements along the study corridor.

- Purpose of the Traffic Analysis: The travel demand modeling performed for the Draft EIS was used as a screening tool for the reasonable alternatives, which included a No-Build Alternative and two Build Alternatives. The traffic operational analysis in the Final EIS considered the Preferred Expressway Alternative only, and focused on determining whether the proposed configuration of the preferred alternative would operate satisfactorily with the projected opening year and design year traffic volumes.

1.3 DEVELOPMENT OF TRAFFIC PROJECTIONS

The Texas Department of Transportation (TxDOT) Transportation Planning and Programming Division (TPP) developed Year 2018, 2038 and 2048 traffic projections for the US 281 Preferred Expressway Alternative. The traffic projections, dated March 7, 2014, were received by Jacobs on March 12, 2014. These traffic projections included a K-factor of 8.2 percent. The design hourly volumes (DHV) for both the Opening Year (2018) and Design Year (2038) were developed using the K-factor.

In 2038, the traffic projections for the managed lanes between Loop 1604 and Stone Oak Parkway showed 26,800 vehicles per day in each direction. Using the K-factor, the peak DHV for the managed lanes was approximately 2,200 vehicles per hour (vph).

For congested corridors, empirical research on managed lanes has shown that these lanes need to operate between 1,400 vph and 1,700 vph to provide benefits to the vehicles within the lane. Therefore, the 2038 DHV for the managed lanes using the TPP traffic projections was too high.

A sensitivity test was performed on the managed lanes traffic volume to determine the appropriate volume for the operational analysis. Initially, the TPP traffic volume was redistributed from the managed lanes to the general purpose lanes to achieve 1,600 vph within the managed lanes. The densities of the general purpose lanes were then compared between the 2,200 vph and 1,600 vph on the managed lanes for significant differences and operational benefits. Based upon the differences, the managed lanes traffic volume would maintain the desired operational benefit. Finally, the TPP traffic volumes were redistributed from the managed lanes to the general purpose lanes to achieve 700 vph in the managed lane.

1.4 OPERATIONAL ANALYSIS METHODOLOGY

The daily traffic projections for each element for US 281 were provided by TPP for the years 2018, 2038, and 2048. These projections are in the **Attachments** to this memorandum. The DHV were developed by using the 8.2 percent K-factor and are the basis for the traffic operational analyses along the corridor.

The 2010 Edition of the *Highway Capacity Manual (HCM2010)* prescribes procedures to analyze freeway corridors and ancillary facilities, and also defines the Measures of Effectiveness (MOEs) used to analyze traffic operating conditions. However, a shortcoming of *HCM2010* procedures is that it does not fully consider the traffic interaction between different elements of a highway corridor, nor does it fully account for the congestion effect that a segment of highway will have on both the upstream segment and the downstream segment. Therefore, the microscopic simulation tool VISSIM was used to evaluate the US 281 corridor for opening and design year analyses for all of the freeway segments, ramps, frontage roads and intersections. For traffic operation on freeway segments, ramps and frontage road, density and travel time were used as MOEs and for Intersections, total delay was used as the MOE.

Traffic signals were coded in Synchro Professional version 8 (Synchro), a traffic signal operations and optimization tool, to develop appropriate phasing and timing information at each intersection in both the 2018 and 2038 scenarios. These signal phasing and timings were used in the VISSIM models to simulate the traffic operations for these two analysis years.

The level of service (LOS) for the study corridor was then estimated based on *HCM2010* guidelines. LOS is a quantifiable set of operating conditions which describe the relative ease or difficulty for completing a vehicle trip on a particular roadway. The highest LOS "A" is where there is virtually no constraint to the progress of a vehicle trip, where speeds are fairly uniform and high, and the density and total volume of traffic is low. The lowest LOS "F" is characterized by frequent stops and speeds changes with high densities of traffic. The acceptable LOS for the US 281 traffic operation analysis is LOS "D" for the basic freeway segments and LOS "D" for the ramps, weaving areas, frontage roads, and intersections.

There is a small difference in the preliminary design schematic between the opening and the design years. The description of the Preferred Expressway Alternative mentioned above is the design year geometry. The opening year has two managed expressway lanes in each direction between Stone Oak Parkway and Borgfeld Drive.

- As no plans exist for the future roadway configurations of Marshall Road, Northwind Boulevard, Wilderness Oak Future, and Overlook Parkway, it was assumed that these intersections include two through lanes and one right turn lane as they approach the US 281 frontage roads.

1.5 VISSIM ANALYSIS

Opening Year (2018) and Design Year (2038) traffic operations along the US 281 corridor between Loop 1604 and Borgfeld Drive was studied using VISSIM microscopic simulation software (version 5.4-12).

VISSIM is a microscopic, time-step and behavior-based simulation software developed to model urban traffic and public transit operations. The program analyzes traffic and transit operations under a series of adjustable parameters such as lane configuration, traffic composition, traffic control devices, and transit stops, among others. For traffic operations, it can provide a diverse array of MOEs such as average total delay, travel times, and densities.

Using the following steps, the VISSIM models were developed to analyze the 2018 and 2038 preliminary design schematic of the study corridor.

- Scaled and imported the AutoCAD drawing of the corridor as the background;
- Developed network geometry (number of lanes, lane widths acceleration/deceleration lane lengths, lane closures);
- Coded desired speed decisions;
- Coded reduced speed areas where appropriate;
- Coded priority rules where appropriate;
- Coded traffic signal controllers and traffic signal heads;
- Coded traffic signal timings, optimized using Synchro to accommodate 2018 and 2038 volumes (created *.rbc signal controller files);
- Coded input volumes and routing decisions; and
- Coded travel time segments (one in the northbound direction from Loop 1604 to Borgfeld Drive and the other in the southbound direction from the Borgfeld Drive to Loop 1604).

In order to ensure an accurate replication of the congestion occurring during the peak hour, a 15 minute pre-load period is included as a standard practice in microscopic simulation, and is recommended and preferred by Federal Highway Administration (FHWA).

It should be noted that, both VISSIM models (2018 and 2038) were run for ten (10) simulation runs with different seed numbers. The MOEs were extracted from the multiple simulation runs and their results averaged before comparing with the input volumes, thus minimizing the chance of outliers yielded by the stochastic element of the software. Furthermore, to prevent the bias caused by an initially empty network, MOEs were collected only after the simulation had run for 15 minutes (0-900 seconds of warm up time). MOEs were then collected for the design one-hour peak period (i.e. 60 minutes between 900 – 4,500 seconds).

Both the VISSIM models (2018 and 2038) used the car following and lane changing parameters that are included in the **Attachments** to this memorandum.

1.5.1 2018 DESIGN SCHEMATIC ANALYSIS

During the 2018 Design Peak Hour, the results of the VISSIM analysis show decent speeds in the study corridor both in the northbound and southbound directions, with the proposed improvements in place. Similarly, densities and LOS along the study corridor were shown to be at acceptable levels. The entire study corridor was found to operate at LOS "B" or better, except (1) the freeway segment in the southbound direction between the Encino entrance ramp and the exit ramp to the Loop 1604 Direct Connect

ramps (DCs) and (2) the southbound entrance ramp from Sonterra Boulevard, both of which operate at LOS "C." **Table 1** and **Table 2** show the density and LOS for all of freeway segments and ramps in the study corridor. Speed, density, and link LOS line diagrams are provided in the **Attachments** to this memorandum.

Table 1

Freeway Segments - 2018 Density & LOS

Direction	Link No.	Segment		Segment Type	Density/Lane (pc/mi/ln)	LOS
		From	To			
SB	41	North End of Study Area	Borgfeld Exit Ramp	Basic Freeway	13.8	B
	44	Borgfeld Exit Ramp	Bulverde Exit Ramp	Basic Freeway	11.4	B
	45	Bulverde Exit Ramp	Borgfeld Entrance Ramp	Basic Freeway	10.8	A
	47	Borgfeld Entrance Ramp	Overlook Exit Ramp	Weaving	10.3	A
	49	Overlook Exit Ramp	Bulverde Entrance Ramp	Basic Freeway	13.7	B
	106	Bulverde Entrance Ramp	Marshall Exit Ramp	Basic Freeway	14.6	B
	51	Marshall Exit Ramp	Wilderness Entrance Ramp	Basic Freeway	13.1	B
	54	Wilderness Entrance Ramp	Stone Oak Exit Ramp	Weaving	9.3	A
	55	Stone Oak Exit Ramp	Marshall Entrance Ramp	Basic Freeway	12.1	B
	59	Marshall Entrance Ramp	Evans Exit Ramp	Weaving	8.4	A
	125	Evans Exit Ramp	Stone Oak Entrance Ramp	Basic Freeway	15.5	B
	65	Stone Oak Entrance Ramp	Encino Exit Ramp	Weaving	15.9	B
	67	Encino Exit Ramp	Redland Exit Ramp	Basic Freeway	15.5	B
	183	Redland Exit Ramp	Encino Entrance Ramp	Basic Freeway	14.3	B
	192	Encino Entrance Ramp	DCs to Loop 1604	Basic Freeway	19.0	C
	70	DCs to Loop 1604	Managed Lane Exit Ramp	Basic Freeway	15.4	B
	71	Managed Lane Exit Ramp	Sonterra Entrance Ramp	Basic Freeway	12.5	B
	260	Sonterra Entrance Ramp	South End of Study Area	Basic Freeway	13.8	B
NB	1	South End of Study Area	Sonterra Exit Ramp	Basic Freeway	16.9	B
	43	Sonterra Exit Ramp	Loop 1604 FR Entrance Ramp	Basic Freeway	12.0	B
	7	Loop 1604 FR Entrance Ramp	DCs from Loop 1604	Basic Freeway	15.5	B
	8	DCs from Loop 1604	Encino Rio Exit Ramp	Weaving	13.3	B
	9	Encino Rio Exit Ramp	Encino Entrance Ramp	Basic Freeway	13.2	B
	12	Encino Entrance Ramp	Stone Oak Exit Ramp	Weaving	11.3	B
	16	Stone Oak Exit Ramp	Evans Entrance Ramp	Basic Freeway	15.1	B
	19	Evans Entrance Ramp	Marshall Exit Ramp	Weaving	11.7	B
	23	Marshall Exit Ramp	Stone Oak Entrance Ramp	Basic Freeway	9.2	A
	24	Stone Oak Entrance Ramp	Managed Lane Egress	Weaving	7.0	A
	253	Managed Lane Egress	Wilderness Exit Ramp	Weaving	7.5	A
	299	Wilderness Exit Ramp	Marshall Entrance Ramp	Basic Freeway	12.7	B
	30	Marshall Entrance Ramp	Bulverde Exit Ramp	Basic Freeway	14.3	B
	33	Bulverde Exit Ramp	Overlook Entrance Ramp	Basic Freeway	13.5	B
	135	Overlook Entrance Ramp	Borgfeld Exit Ramp	Weaving	10.1	A
	34	Borgfeld Exit Ramp	Bulverde Entrance Ramp	Basic Freeway	11.6	B
	37	Bulverde Entrance Ramp	Borgfeld Entrance Ramp	Basic Freeway	12.4	B
	42	Borgfeld Entrance Ramp	North End of Study Area	Basic Freeway	13.5	B

Table 2

Ramp Segments - 2018 Density & LOS

Direction	Link No.	Segment	Density/Lane (pc/mi/ln)	LOS
SB	137	Exit Ramp to Borgfeld	2.3	A
	46	Exit Ramp to Bulverde	1.9	A
	48	Entrance Ramp from Borgfeld	10.3	B
	50	Exit Ramp to Overlook	4.0	A
	136	Entrance Ramp from Bulverde	2.2	A
	52	Exit Ramp to Marshall	3.7	A
	53	Entrance Ramp from Wilderness	12.9	B
	56	Exit Ramp to Stone Oak	1.0	A
	57	Entrance Ramp from Marshall	3.9	A
	60	Park & Ride Exit Ramp	0.7	A
	62	Exit Ramp to Evans	6.8	A
	63	Exit Ramp to Managed Lanes	5.5	A
	66	Entrance Ramp from Stone Oak	19.7	B
	68	Exit Ramp to Encino	0.9	A
	196	Exit Ramp to Redland	5.0	A
	197	Entrance Ramp from Encino	15.6	B
	72	Exit Ramp to Loop 1604 DCs	16.2	B
	69	Entrance Ramp from Managed Lanes	6.3	A
	201	Entrance Ramp from Sonterra	21.5	C
NB	200	Exit Ramp to Sonterra	16.7	B
	3	Entrance Ramp Loop 1604 FR	1.2	A
	10	Exit Ramp to Managed Lanes	6.4	A
	262	Entrance Ramp from Loop 1604 DCs	16.5	B
	11	Exit Ramp to Encino	8.3	A
	13	Entrance Ramp from Encino	6.4	A
	14	Exit Ramp to Stone Oak	18.2	B
	20	Entrance Ramp to Evans	7.6	A
	22	Exit Ramp to Marshall	9.0	A
	17	Entrance Ramp from Managed Lanes	5.7	A
	26	Entrance Ramp from Park & Ride	0.7	A
	25	Entrance Ramp from Stone Oak	1.8	A
	29	Exit Ramp to Wilderness	5.4	A
	31	Entrance Ramp from Marshall	3.6	A
	111	Exit Ramp to Bulverde	1.8	A
	32	Entrance Ramp from Overlook	3.6	A
	35	Exit Ramp to Borgfeld	8.2	A
	38	Entrance Ramp from Bulverde	1.8	A
	40	Entrance Ramp from Borgfeld	1.4	A

Output (processed) volumes were collected in VISSIM for the design peak hour to ensure that the input (demand) volume on the proposed roadway network enters the system and is used by VISSIM. The VISSIM model was able to process 99 percent of the demand volume in the study corridor. Line diagrams showing the processed volumes and tables showing the volume comparisons are found in the **Attachments** to this memorandum.

In addition to the analysis of the expressway lanes, intersection analysis of the proposed cross streets was also performed for the Preferred Expressway Alternative. The results from the VISSIM analysis show that all of the cross street intersections and approaches are anticipated to operate at a LOS "C" or better with the proposed improvements in place, except some of the approaches at the intersections of Marshall Road and Stone Oak Parkway with the frontage roads/outer lanes, which are anticipated to operate at LOS "D." **Table 3** shows the approach control delay, intersection control delay, approach LOS and intersection LOS. Approach / Intersection Control Delay and LOS line diagrams are provided in the **Attachments** to this memorandum.

Table 3

2018 Delay & LOS (Approach/ Intersection)

Intersection	Approach	Average Delay (sec)	Approach Level of Service	Overall Delay (sec)	Overall Level of Service
Redland & NB FR	Southbound	-	-	8.64	A
	Westbound	14.2	B		
	Northbound	5.9	A		
	Eastbound	5.8	A		
Redland & SB FR	Southbound	19.4	B	11.92	B
	Westbound	4.5	A		
	Northbound	-	-		
	Eastbound	-	-		
Encino & NB FR	Southbound	-	-	16.27	B
	Westbound	23.6	C		
	Northbound	24.9	C		
	Eastbound	0.3	A		
Encino & SB FR	Southbound	26.6	C	13.79	B
	Westbound	1.0	A		
	Northbound	-	-		
	Eastbound	-	-		
Evans & NB FR	Southbound	-	-	22.99	C
	Westbound	34.7	C		
	Northbound	33.0	C		
	Eastbound	1.3	A		
Evans & SB FR	Southbound	19.8	B	17.52	B
	Westbound	1.2	A		
	Northbound	-	-		
	Eastbound	31.6	C		
Stone Oak & NB FR	Southbound	-	-	22.29	C
	Westbound	44.8	D		
	Northbound	21.1	C		
	Eastbound	0.9	A		

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Intersection	Approach	Average Delay (sec)	Approach Level of Service	Overall Delay (sec)	Overall Level of Service
Stone Oak & SB FR	Southbound	44.3	D	30.46	C
	Westbound	2.1	A		
	Northbound	-	-		
	Eastbound	44.9	D		
Marshall & NB FR	Southbound	-	-	21.99	C
	Westbound	41.4	D		
	Northbound	22.5	C		
	Eastbound	2.0	A		
Marshall & SB FR	Southbound	49.1	D	28.26	C
	Westbound	8.6	A		
	Northbound	-	-		
	Eastbound	27.1	C		
Wilderness & NB FR	Southbound	-	-	22.49	C
	Westbound	34.2	C		
	Northbound	32.6	C		
	Eastbound	0.7	A		
Wilderness & SB FR	Southbound	29.6	C	20.18	C
	Westbound	0.3	A		
	Northbound	-	-		
	Eastbound	30.6	C		
Overlook & NB FR	Southbound	-	-	17.57	B
	Westbound	25.2	C		
	Northbound	25.9	C		
	Eastbound	1.7	A		
Overlook & SB FR	Southbound	14.2	B	11.28	B
	Westbound	1.3	A		
	Northbound	-	-		
	Eastbound	18.4	B		
Bulverde & NB FR	Southbound	-	-	12.11	B
	Westbound	22.4	C		
	Northbound	6.7	A		
	Eastbound	7.2	A		
Bulverde & SB FR	Southbound	22.5	C	14.67	B
	Westbound	4.1	A		
	Northbound	-	-		
	Eastbound	17.4	B		
Borgfeld & NB FR	Southbound	-	-	19.80	B
	Westbound	32.4	C		
	Northbound	25.1	C		
	Eastbound	1.9	A		
Borgfeld & SB FR	Southbound	12.5	B	10.14	B
	Westbound	4.7	A		
	Northbound	-	-		
	Eastbound	13.2	B		

1.5.2 2038 DESIGN SCHEMATIC ANALYSIS

During the 2038 Design Peak Hour, the results of the VISSIM analysis show decent speeds in the study corridor both in the northbound and southbound directions. Similarly, densities and LOS along the study corridor are at acceptable levels. The northbound roadway segments are anticipated to operate at LOS "C" or better throughout the study corridor, with the proposed improvements in place, except (1) the freeway segment in the southbound direction between the entrance ramp from Encino Rio and the exit ramp to the Loop 1604 DCs, and (2) upstream of the Sonterra Boulevard exit ramp. The northbound direction, southbound on-ramp from Stone Oak Parkway, and northbound off-ramp to Stone Oak Parkway operate at LOS "D". **Table 4** and **Table 5** show the density and LOS for all of the freeway segments and ramps in the study corridor. Speed, density, and link LOS line diagrams are provided in the **Attachments** to this memorandum.

Table 4

Freeway Segments - 2038 Density & LOS

Direction	Link No.	Segment		Segment Type	Density/Lane (pc/mi/ln)	LOS
		From	To			
SB	41	North End of Study Area	Borgfeld Exit Ramp	Basic Freeway	21.8	C
	44	Borgfeld Exit Ramp	Bulverde Exit Ramp	Basic Freeway	11.8	B
	45	Bulverde Exit Ramp	Borgfeld Entrance Ramp	Basic Freeway	11.2	B
	47	Borgfeld Entrance Ramp	Overlook Exit Ramp	Weaving	16.3	B
	49	Overlook Exit Ramp	Bulverde Entrance Ramp	Basic Freeway	14.3	B
	106	Bulverde Entrance Ramp	Marshall Exit Ramp	Basic Freeway	15.0	B
	51	Marshall Exit Ramp	Wilderness Entrance Ramp	Basic Freeway	13.5	B
	54	Wilderness Entrance Ramp	Stone Oak Exit Ramp	Weaving	14.6	B
	55	Stone Oak Exit Ramp	Marshall Entrance Ramp	Basic Freeway	19.0	C
	59	Marshall Entrance Ramp	Evans Exit Ramp	Weaving	13.1	B
	125	Evans Exit Ramp	Stone Oak Entrance Ramp	Basic Freeway	24.3	C
	65	Stone Oak Entrance Ramp	Encino Exit Ramp	Weaving	24.5	C
	67	Encino Exit Ramp	Redland Exit Ramp	Basic Freeway	23.6	C
	183	Redland Exit Ramp	Encino Entrance Ramp	Basic Freeway	21.8	C
	192	Encino Entrance Ramp	DCs to Loop 1604	Basic Freeway	32.5	D
	70	DCs to Loop 1604	Managed Lane Exit Ramp	Basic Freeway	23.8	C
	71	Managed Lane Exit Ramp	Sonterra Entrance Ramp	Basic Freeway	18.8	C
	260	Sonterra Entrance Ramp	South End of Study Area	Basic Freeway	19.6	C
NB	1	South End of Study Area	Sonterra Exit Ramp	Basic Freeway	27.0	D
	43	Sonterra Exit Ramp	Loop 1604 FR Entrance Ramp	Basic Freeway	19.2	C
	7	Loop 1604 FR Entrance Ramp	DC's from Loop 1604	Basic Freeway	24.8	C
	8	DC's from Loop 1604	Encino Rio Exit Ramp	Weaving	21.0	C
	9	Encino Rio Exit Ramp	Encino Entrance Ramp	Basic Freeway	20.9	C
	12	Encino Entrance Ramp	Stone Oak Exit Ramp	Weaving	17.9	B
	16	Stone Oak Exit Ramp	Evans Entrance Ramp	Basic Freeway	24.7	C
	19	Evans Entrance Ramp	Marshall Exit Ramp	Weaving	18.8	C
	23	Marshall Exit Ramp	Stone Oak Entrance Ramp	Basic Freeway	14.7	B
	24	Stone Oak Entrance Ramp	Managed Lane Egress	Weaving	11.3	B
	253	Managed Lane Egress	Wilderness Exit Ramp	Weaving	12.0	B
	28	Wilderness Exit Ramp	Marshall Entrance Ramp	Basic Freeway	13.6	B
	30	Marshall Entrance Ramp	Bulverde Exit Ramp	Basic Freeway	15.1	B
	33	Bulverde Exit Ramp	Overlook Entrance Ramp	Basic Freeway	14.4	B
	135	Overlook Entrance Ramp	Borgfeld Exit Ramp	Weaving	12.2	B
	34	Borgfeld Exit Ramp	Bulverde Entrance Ramp	Basic Freeway	12.4	B
	37	Bulverde Entrance Ramp	Borgfeld Entrance Ramp	Basic Freeway	20.1	C
	42	Borgfeld Entrance Ramp	North End of Study Area	Basic Freeway	22.2	C

Table 5

Ramp Segments - 2038 Density & LOS

Direction	Link No.	Segment	Density/Lane (pc/mi/ln)	LOS
SB	137	Exit Ramp to Borgfeld	3.5	A
	46	Exit Ramp to Bulverde	2.9	A
	48	Entrance Ramp from Borgfeld	16.0	B
	50	Exit Ramp to Overlook	6.1	A
	136	Entrance Ramp from Bulverde	2.8	A
	52	Exit Ramp to Marshall	5.5	A
	53	Entrance Ramp from Wilderness	20.9	C
	56	Exit Ramp to Stone Oak	1.8	A
	57	Entrance Ramp from Marshall	6.1	A
	60	Park & Ride Exit Ramp	1.5	A
	62	Exit Ramp to Evans	10.7	B
	63	Exit Ramp to Managed Lanes	8.8	A
	66	Entrance Ramp from Stone Oak	30.3	D
	68	Exit Ramp to Encino	1.6	A
	196	Exit Ramp to Redland	7.8	A
	197	Entrance Ramp from Encino	23.1	C
	72	Exit Ramp to Loop 1604 DCs	24.9	C
	69	Entrance Ramp from Managed Lanes	10.4	B
	201	Entrance Ramp from Sonterra	27.0	C
NB	200	Exit Ramp to Sonterra	25.9	C
	3	Entrance Ramp Loop 1604 FR	1.9	A
	10	Exit Ramp to Managed Lanes	9.7	A
	262	Entrance Ramp from Loop 1604 DCs	26.2	C
	11	Exit Ramp to Encino	12.9	B
	13	Entrance Ramp from Encino	10.3	B
	14	Exit Ramp to Stone Oak	28.9	D
	20	Entrance Ramp to Evans	12.3	B
	22	Exit Ramp to Marshall	14.2	B
	17	Entrance Ramp from Managed Lanes	9.3	A
	26	Entrance Ramp from Park & Ride	1.5	A
	25	Entrance Ramp from Stone Oak	3.0	A
	29	Exit Ramp to Wilderness	8.5	A
	31	Entrance Ramp from Marshall	5.6	A
	111	Exit Ramp to Bulverde	2.6	A
	32	Entrance Ramp from Overlook	5.7	A
	35	Exit Ramp to Borgfeld	13.4	B
	38	Entrance Ramp from Bulverde	2.8	A
	40	Entrance Ramp from Borgfeld	2.7	A

Output (processed) volumes were collected in VISSIM for the design peak hour to ensure that the input (demand) volume on the proposed roadway network enters the system and is used by VISSIM. The VISSIM model was able to process 99 percent of the demand volume in the study corridor. Line diagrams showing the processed volumes and tables showing the volume comparisons are found in the **Attachments** to this memorandum.

In addition to the analysis of the expressway lanes, intersection analyses were performed for the proposed cross street intersections for the 2038 Design Peak Hour Volumes. The results from the VISSIM analysis shows that all of the cross street intersections and approaches are anticipated to operate at LOS "D" or better with the proposed improvements in place, except some of the approaches at the intersections of Stone Oak Parkway and Marshall Road with the northbound and southbound frontage roads/outer lanes, which are anticipated to operate at LOS "E" and LOS "F." **Table 6** shows the approach control delay, intersection control delay, approach LOS and intersection LOS. Line diagrams of the approach and intersection control delay and LOS are provided in **Attachments** to this memorandum.

Table 6

2038 Delay & LOS

Intersection	Approach	Average Delay (sec)	Approach Level of Service	Overall Delay (sec)	Overall Level of Service
Redland & NB FR	Southbound	-	-	8.93	A
	Westbound	14.0	B		
	Northbound	6.9	A		
	Eastbound	5.9	A		
Redland & SB FR	Southbound	22.1	C	12.81	B
	Westbound	3.6	A		
	Northbound	-	-		
	Eastbound	-	-		
Encino & NB FR	Southbound	-	-	18.97	B
	Westbound	25.9	C		
	Northbound	30.6	C		
	Eastbound	0.4	A		
Encino & SB FR	Southbound	31.7	C	16.44	B
	Westbound	1.2	A		
	Northbound	-	-		
	Eastbound	-	-		
Evans & NB FR	Southbound	-	-	33.15	C
	Westbound	48.7	D		
	Northbound	49.4	D		
	Eastbound	1.4	A		
Evans & SB FR	Southbound	26.3	C	22.01	C
	Westbound	1.9	A		
	Northbound	-	-		
	Eastbound	37.8	D		
Stone Oak & NB FR	Southbound	-	-	35.52	D
	Westbound	79.5	E		
	Northbound	25.8	C		
	Eastbound	1.3	A		

Intersection	Approach	Average Delay (sec)	Approach Level of Service	Overall Delay (sec)	Overall Level of Service
Stone Oak & SB FR	Southbound	48.4	D	97.06	F
	Westbound	4.8	A		
	Northbound	-	-		
	Eastbound	237.9	F		
Marshall & NB FR	Southbound	-	-	33.77	C
	Westbound	73.4	E		
	Northbound	26.6	C		
	Eastbound	1.4	A		
Marshall & SB FR	Southbound	52.0	D	32.72	C
	Westbound	16.8	B		
	Northbound	-	-		
	Eastbound	29.3	C		
Wilderness & NB FR	Southbound	-	-	25.12	C
	Westbound	35.3	D		
	Northbound	39.3	D		
	Eastbound	0.8	A		
Wilderness & SB FR	Southbound	33.6	C	23.38	C
	Westbound	0.5	A		
	Northbound	-	-		
	Eastbound	36.0	D		
Overlook & NB FR	Southbound	-	-	22.22	C
	Westbound	29.5	C		
	Northbound	35.2	D		
	Eastbound	2.0	A		
Overlook & SB FR	Southbound	17.7	B	13.33	B
	Westbound	1.6	A		
	Northbound	-	-		
	Eastbound	20.7	C		
Bulverde & NB FR	Southbound	-	-	12.59	B
	Westbound	24.0	C		
	Northbound	7.6	A		
	Eastbound	6.1	A		
Bulverde & SB FR	Southbound	22.9	C	16.25	B
	Westbound	6.7	A		
	Northbound	-	-		
	Eastbound	19.2	B		
Borgfeld & NB FR	Southbound	-	-	26.13	C
	Westbound	48.4	D		
	Northbound	28.0	C		
	Eastbound	2.1	A		
Borgfeld & SB FR	Southbound	13.7	B	11.97	B
	Westbound	8.8	A		
	Northbound	-	-		
	Eastbound	13.3	B		

1.6 TRAVEL TIME

Travel time studies were completed on May 7, 2014 for the US 281 project corridor. Two drivers made three runs each during the morning and evening rush hours using GPS-based travel time tablets. During the evening rush hour travel time study, traffic heading northbound into the study corridor was impeded by an accident near Bitters Road (3 miles south of the study corridor), which had traffic in two of the three lanes blocked. Also, this is the same night as one of the Spurs playoff games, which may have diverted some traffic away from a normal commute home. As a result, traffic congestion north of Loop 1604 was potentially less than a normal day. Travel times for the northbound direction would have likely increased if not for these events.

We compared true travel times versus those predicted by the 2018 and 2038 VISSIM models. In addition to processed volume, density, and speeds, travel times for the US 281 project corridor were defined along the expressway lanes for each direction in the VISSIM models (one in the northbound direction and one in the southbound direction, between Loop 1604 and Borgfeld Drive). **Table 7** and **Table 8** show that there is an anticipated travel time savings of 48 percent in the northbound direction and 63 percent in the southbound direction, when compared to the existing conditions for both the 2018 and 2038 models, respectively.

Table 7

2018 Travel Time Comparison

Direction	Existing		2018		Difference (sec)	% Difference
	Travel Time (sec)	Travel Time (min)	Travel Time (sec)	Travel Time (min)		
NB US 281	863	14.38	446	7.44	417	48%
SB US 281	1213	20.21	448	7.46	765	63%

Table 8

2038 Travel Time Comparison

Direction	Existing		2038		Difference (sec)	% Difference
	Travel Time (sec)	Travel Time (min)	Travel Time (sec)	Travel Time (min)		
NB US 281	863	14.38	452	7.53	411	48%
SB US 281	1213	20.21	453	7.55	759	63%

1.7 CONCLUSIONS

Based on the information provided above, the following conclusions can be drawn:

- Opening Year:
  - All managed lanes, general purpose lanes, ramps, frontage road/outer lanes, and intersections would operate satisfactorily with a LOS "C" or better.
- Design Year
  - Most of the managed lanes, general purpose lanes, ramps, frontage road/outer lanes, and intersections would operate satisfactorily with a LOS "C" or better.
  - There was one segment that would operate at LOS "D" as a result of the Preferred Expressway Alternative. This section is southbound between the Encino Rio entrance ramp and the Loop 1604 DCs exit ramp.
  - There were two ramps that would operate at LOS "D". These ramps were the southbound entrance ramp from Stone Oak Parkway and the northbound exit ramp to Stone Oak Parkway.
  - The Stone Oak Parkway / TPC Parkway intersections with both the southbound and northbound frontage roads would operate unsatisfactorily, LOS "D/F".
  - Even though most approaches at the intersections would operate at LOS "D" or better, there were three approaches with a LOS "E" or "F." These approaches are the westbound approach from TPC Parkway to the northbound frontage road, the eastbound approach from Stone Oak Parkway to the southbound frontage road, and the westbound approach from Marshall Road to the northbound US 281 outer lanes.
- The opening and design years would operate satisfactorily with the TPP-developed traffic projections, with the exception of the Stone Oak Parkway / TPC Parkway intersections with the frontage roads.
- To accommodate the anticipated traffic at Stone Oak Parkway / TPC Parkway, the frontage road intersections would need to be widened/expanded in the future to relieve the anticipated congestion at this location. We recommend that this interchange be monitored for possible future expansion.

Bexar County is planning on expanding Marshall Road between US 281 and Bulverde Road in the next few years. We recommend that Bexar County consider expanding Marshall Road to a 6-lane divided roadway to help alleviate the anticipated congestion at the Stone Oak Parkway / TPC Parkway / US 281 interchange.

Attachments

A) TPP Traffic Projections

B) VISSIM Line Diagrams

a. 2018-2038 Input Volumes

b. 2018 Processed Volumes

c. 2018 Densities

d. 2018 Link LOS

e. 2018 Speed

f. 2018 Intersection LOS

g. 2018 Freeway and Ramp Volume Comparison

h. 2038 Processed Volumes

i. 2038 Densities

j. 2038 Link LOS

k. 2038 Speed

l. 2038 Intersection LOS

m. 2038 Freeway and Ramp Volume Comparison

C) VISSIM Parameters

Texas Department of Transportation

MEMO

March 7, 2014

To: Mario R. Jorge, P.E.
Attention: Jonathan Bean, P.E.

From: William E. Knowles, P.E.

Subject: Traffic Data
CSJ: 0253-04-138
US 281:
From Loop 1604
To Borgfeld

Bexar County

Attached are copies of schematics depicting 2018, 2038 and 2048 anticipated average daily traffic volumes and turning movements along US 281 for both existing and proposed conditions. Also attached are tabulations showing traffic analysis for highway design for the 2018 to 2038 twenty year period and 2018 to 2048 thirty year period for the described limits of the route. Included are tabulations showing data for use in air and noise analysis.

This data supersedes the information from the project provided to your office on January 31, 2014.

Due to significant differences in traffic volumes this project was separated into three sections.

Section 1: From Loop 1604 to Evans Road
Section 2: From Evans Road to Bulverde Road
Section 3: From Bulverde Road to Borgfeld Drive

Please refer to your original memorandum dated December 16, 2013. Revised schematics were received on January 9th, January 13th, and February 24th 2014 and are considered in this analysis. Only Free Flow traffic volumes are provided.

If you have any questions or need additional information, please contact Robert Williams at (512) 486-5145.

Attachments

CC: Melissa Bernal, San Antonio District
Design Division

TRAFFIC ANALYSIS FOR HIGHWAY DESIGN

San Antonio District **March 7, 2014**

Description of Location	Average Daily Traffic 2018	Average Daily Traffic 2038	Base Year Dir Dist %	Base Year K Factor	Base Year Percent Trucks ADT	Base Year Percent Trucks DHV	ATHWLD	Percent Tandem Axles in ATHWLD	Total Number of Equivalent 18k Single Axle Load Applications One Direction Expected for a 20 Year Period (2018 to 2038) Flexible Pavement	S N	Rigid Pavement	SLAB
US 281 (Existing Lane Configuration) Section 1												
From Loop 1604 To Evans Rd.	137,100	213,500	53 - 47	8.2	2.9	1.7	12,400	20	12,805,000	3	15,727,000	8"
							12,400	20	12,805,000	3	16,104,000	13"
Bexar County												

Data for Use in Air & Noise Analysis

Vehicle Class	Base Year % of ADT	Base Year % of DHV
Light Duty	97.1	98.3
Medium Duty	1.8	1.1
Heavy Duty	1.1	0.6

Description of Location	Average Daily Traffic 2018	Average Daily Traffic 2048	Base Year Dir Dist %	Base Year K Factor	Base Year Percent Trucks ADT	Base Year Percent Trucks DHV	ATHWLD	Percent Tandem Axles in ATHWLD	Total Number of Equivalent 18k Single Axle Load Applications One Direction Expected for a 30 Year Period (2018 to 2048) Flexible Pavement	S N	Rigid Pavement	SLAB
US 281 (Existing Lane Configuration) Section 1												
From Loop 1604 To Evans Rd.	137,100	235,500	53 - 47	8.2	2.9	1.7	12,500	20	20,413,000	3	25,071,000	8"
							12,500	20	20,413,000	3	25,672,000	13"
Bexar County												

TRAFFIC ANALYSIS FOR HIGHWAY DESIGN

San Antonio District **March 7, 2014**

Description of Location	Average Daily Traffic 2018	Average Daily Traffic 2038	Base Year Dir Dist %	Base Year K Factor	Base Year Percent Trucks ADT	Base Year Percent Trucks DHV	ATHWLD	Percent Tandem Axles in ATHWLD	Total Number of Equivalent 18k Single Axle Load Applications One Direction Expected for a 20 Year Period (2018 to 2038) Flexible Pavement	S N	Rigid Pavement	SLAB
US 281 (Existing Lane Configuration) Section 2												
From Evans Rd. To Bulverde Rd.	81,400	126,200	53 - 47	8.2	3.9	2.3	12,200	30	10,116,000	3	12,470,000	8"
							12,200	30	10,116,000	3	12,770,000	13"
Bexar County												

Data for Use in Air & Noise Analysis

Vehicle Class	Base Year % of ADT	Base Year % of DHV
Light Duty	96.1	97.7
Medium Duty	2.4	1.4
Heavy Duty	1.5	0.9

Description of Location	Average Daily Traffic 2018	Average Daily Traffic 2048	Base Year Dir Dist %	Base Year K Factor	Base Year Percent Trucks ADT	Base Year Percent Trucks DHV	ATHWLD	Percent Tandem Axles in ATHWLD	Total Number of Equivalent 18k Single Axle Load Applications One Direction Expected for a 30 Year Period (2018 to 2048) Flexible Pavement	S N	Rigid Pavement	SLAB
US 281 (Existing Lane Configuration) Section 2												
From Evans Rd. To Bulverde Rd.	81,400	139,900	53 - 47	8.2	3.9	2.3	12,300	30	16,175,000	3	19,940,000	8"
							12,300	30	16,175,000	3	20,420,000	13"
Bexar County												

TRAFFIC ANALYSIS FOR HIGHWAY DESIGN

San Antonio District **March 7, 2014**

Description of Location	Average Daily Traffic 2018	Average Daily Traffic 2038	Base Year Dir Dist %	Base Year K Factor	Base Year Percent Trucks ADT	Base Year Percent Trucks DHV	ATHWLD	Percent Tandem Axles in ATHWLD	Total Number of Equivalent 18k Single Axle Load Applications One Direction Expected for a 20 Year Period (2018 to 2038) Flexible Pavement	S N	Rigid Pavement	SLAB
US 281 (Existing Lane Configuration) Section 3												
From Bulverde Rd. To Borgfeld Dr.	47,800	74,100	53 - 47	8.2	4.3	2.6	12,000	30	6,535,000	3	8,063,000	8"
							12,000	30	6,535,000	3	8,258,000	13"
Bexar County												

Data for Use in Air & Noise Analysis

Vehicle Class	Base Year % of ADT	Base Year % of DHV
Light Duty	95.7	97.4
Medium Duty	2.6	1.6
Heavy Duty	1.7	1.0

Description of Location	Average Daily Traffic 2018	Average Daily Traffic 2048	Base Year Dir Dist %	Base Year K Factor	Base Year Percent Trucks ADT	Base Year Percent Trucks DHV	ATHWLD	Percent Tandem Axles in ATHWLD	Total Number of Equivalent 18k Single Axle Load Applications One Direction Expected for a 30 Year Period (2018 to 2048) Flexible Pavement	S N	Rigid Pavement	SLAB
US 281 (Existing Lane Configuration) Section 3												
From Bulverde Rd. To Borgfeld Dr.	47,800	82,600	53 - 47	8.2	4.3	2.6	12,000	30	10,486,000	3	12,939,000	8"
							12,000	30	10,486,000	3	13,251,000	13"
Bexar County												

TRAFFIC ANALYSIS FOR HIGHWAY DESIGN

San Antonio District **March 7, 2014**

Description of Location	Average Daily Traffic 2018	Average Daily Traffic 2038	Base Year Dir Dist %	Base Year K Factor	Base Year Percent Trucks ADT	Base Year Percent Trucks DHV	ATHWLD	Percent Tandem Axles in ATHWLD	Total Number of Equivalent 18k Single Axle Load Applications One Direction Expected for a 20 Year Period (2018 to 2038) Flexible Pavement	S N	Rigid Pavement	SLAB
US 281 (Proposed Lane Configuration) Section 1												
From Loop 1604 To Evans Rd.	137,100	213,500	53 - 47	8.2	2.9	1.7	12,400	20	12,805,000	3	15,727,000	8"
							12,400	20	12,805,000	3	16,104,000	13"
Bexar County												

Data for Use in Air & Noise Analysis

Vehicle Class	Base Year % of ADT	Base Year % of DHV
Light Duty	97.1	98.3
Medium Duty	1.8	1.1
Heavy Duty	1.1	0.6

Description of Location	Average Daily Traffic 2018	Average Daily Traffic 2048	Base Year Dir Dist %	Base Year K Factor	Base Year Percent Trucks ADT	Base Year Percent Trucks DHV	ATHWLD	Percent Tandem Axles in ATHWLD	Total Number of Equivalent 18k Single Axle Load Applications One Direction Expected for a 30 Year Period (2018 to 2048) Flexible Pavement	S N	Rigid Pavement	SLAB
US 281 (Proposed Lane Configuration) Section 1												
From Loop 1604 To Evans Rd.	137,100	235,500	53 - 47	8.2	2.9	1.7	12,500	20	20,413,000	3	25,071,000	8"
							12,500	20	20,413,000	3	25,672,000	13"
Bexar County												

TRAFFIC ANALYSIS FOR HIGHWAY DESIGN

San Antonio District **March 7, 2014**

Description of Location	Base Year Average Daily Traffic 2018	Base Year Average Daily Traffic 2038	Dir Dist %	K Factor	Percent Trucks ADT	Percent Trucks DHV	ATHWLD	Percent Tandem Axles in ATHWLD	Total Number of Equivalent 18k Single Axle Load Applications One Direction Expected for a 20 Year Period (2018 to 2038) Flexible Pavement	S N	Rigid Pavement	SLAB
US 281 (Proposed Lane Configuration) Section 2												
From Evans Rd. To Bulverde Rd.	97,100	151,300	53 - 47	8.2	3.5	2.1	12,300	30	10,891,000	3	13,409,000	8"
							12,300	30	10,891,000	3	13,732,000	13"
Bexar County												

Data for Use in Air & Noise Analysis

Vehicle Class	Base Year % of ADT	Base Year % of DHV
Light Duty	96.5	97.9
Medium Duty	2.1	1.3
Heavy Duty	1.4	0.8

Description of Location	Base Year Average Daily Traffic 2018	Base Year Average Daily Traffic 2048	Dir Dist %	K Factor	Percent Trucks ADT	Percent Trucks DHV	ATHWLD	Percent Tandem Axles in ATHWLD	Total Number of Equivalent 18k Single Axle Load Applications One Direction Expected for a 30 Year Period (2018 to 2048) Flexible Pavement	S N	Rigid Pavement	SLAB
US 281 (Proposed Lane Configuration) Section 2												
From Evans Rd. To Bulverde Rd.	97,100	167,200	53 - 47	8.2	3.5	2.1	12,300	20	17,382,000	3	21,401,000	8"
							12,300	20	17,382,000	3	21,915,000	13"
Bexar County												

TRAFFIC ANALYSIS FOR HIGHWAY DESIGN

San Antonio District **March 7, 2014**

Description of Location	Average Daily Traffic 2018	Average Daily Traffic 2038	Base Year Dir Dist %	Base Year K Factor	Base Year Percent Trucks ADT	Base Year Percent Trucks DHV	ATHWLD	Percent Tandem Axles in ATHWLD	Total Number of Equivalent 18k Single Axle Load Applications One Direction Expected for a 20 Year Period (2018 to 2038) Flexible Pavement	S N	Rigid Pavement	SLAB
US 281 (Proposed Lane Configuration) Section 3												
From Bulverde Rd. To Borgfeld Dr.	52,400	82,000	53 - 47	8.2	4.4	2.6	12,000	30	7,368,000	3	9,094,000	8"
							12,000	30	7,368,000	3	9,314,000	13"
Bexar County												

Data for Use in Air & Noise Analysis

Vehicle Class	Base Year % of ADT	Base Year % of DHV
Light Duty	95.6	97.4
Medium Duty	2.7	1.6
Heavy Duty	1.7	1.0

Description of Location	Average Daily Traffic 2018	Average Daily Traffic 2048	Base Year Dir Dist %	Base Year K Factor	Base Year Percent Trucks ADT	Base Year Percent Trucks DHV	ATHWLD	Percent Tandem Axles in ATHWLD	Total Number of Equivalent 18k Single Axle Load Applications One Direction Expected for a 30 Year Period (2018 to 2048) Flexible Pavement	S N	Rigid Pavement	SLAB
US 281 (Proposed Lane Configuration) Section 3												
From Bulverde Rd. To Borgfeld Dr.	52,400	90,400	53 - 47	8.2	4.4	2.6	12,100	30	11,743,000	3	14,494,000	8"
							12,100	30	11,743,000	3	14,844,000	13"
Bexar County												

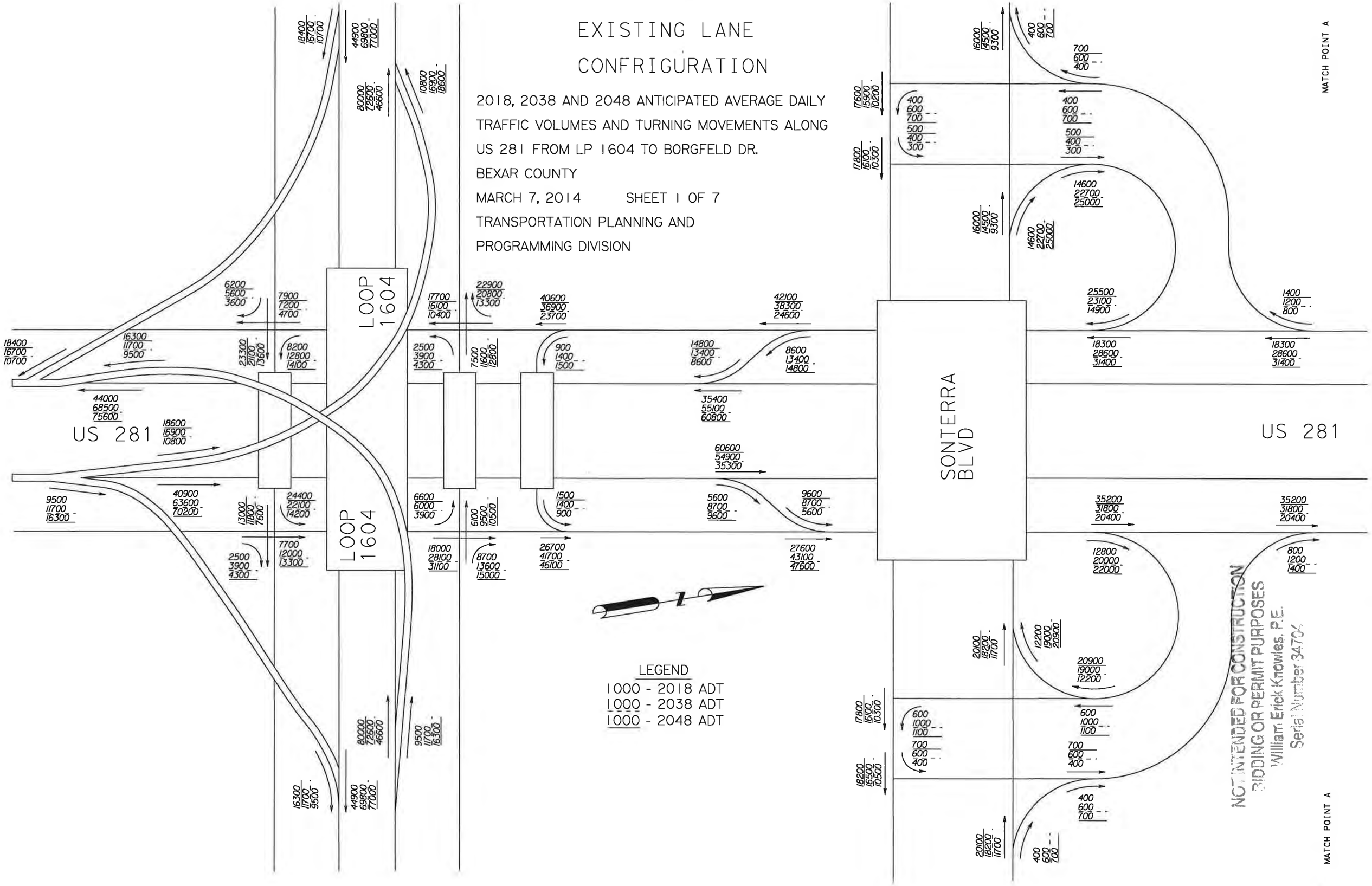
EXISTING LANE CONFRIGURATION

2018, 2038 AND 2048 ANTICIPATED AVERAGE DAILY TRAFFIC VOLUMES AND TURNING MOVEMENTS ALONG US 281 FROM LP 1604 TO BORGFELD DR.

BEXAR COUNTY

MARCH 7, 2014 SHEET 1 OF 7

TRANSPORTATION PLANNING AND PROGRAMMING DIVISION



MATCH POINT A

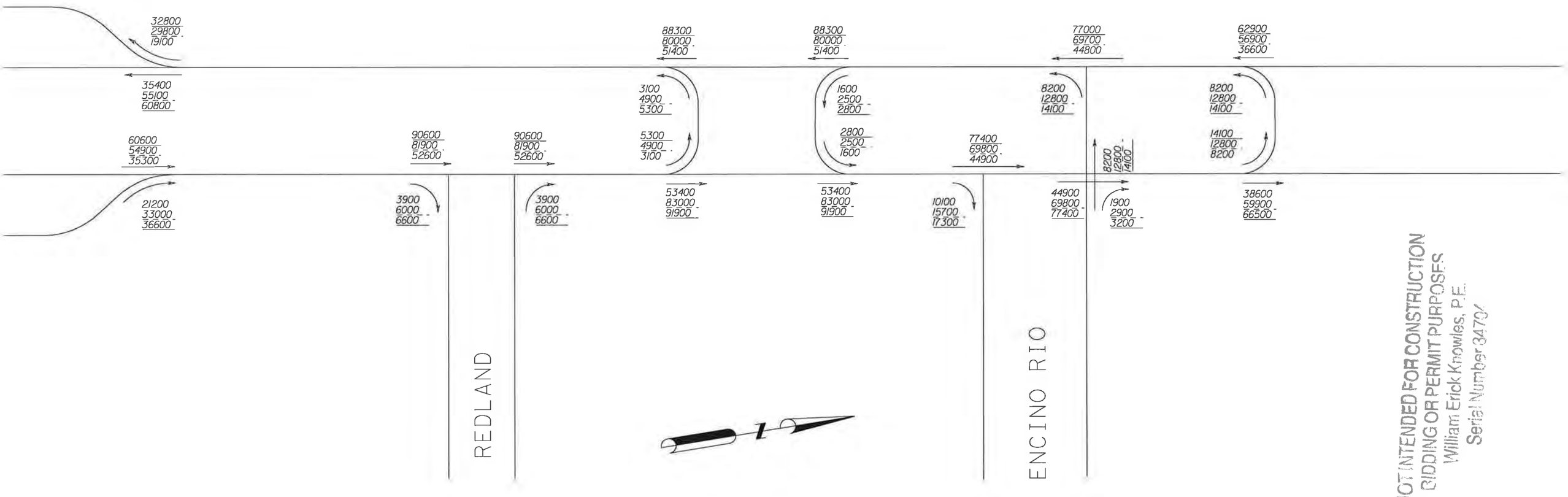
MATCH POINT B

EXISTING LANE CONFRIGURATION

2018, 2038 AND 2048 ANTICIPATED AVERAGE DAILY TRAFFIC VOLUMES AND TURNING MOVEMENTS ALONG US 281 FROM LP 1604 TO BORGFELD DR. BEXAR COUNTY

MARCH 7, 2014 SHEET 2 OF 7

TRANSPORTATION PLANNING AND PROGRAMMING DIVISION



LEGEND

1000 - 2018 ADT

1000 - 2038 ADT

1000 - 2048 ADT

MATCH POINT A

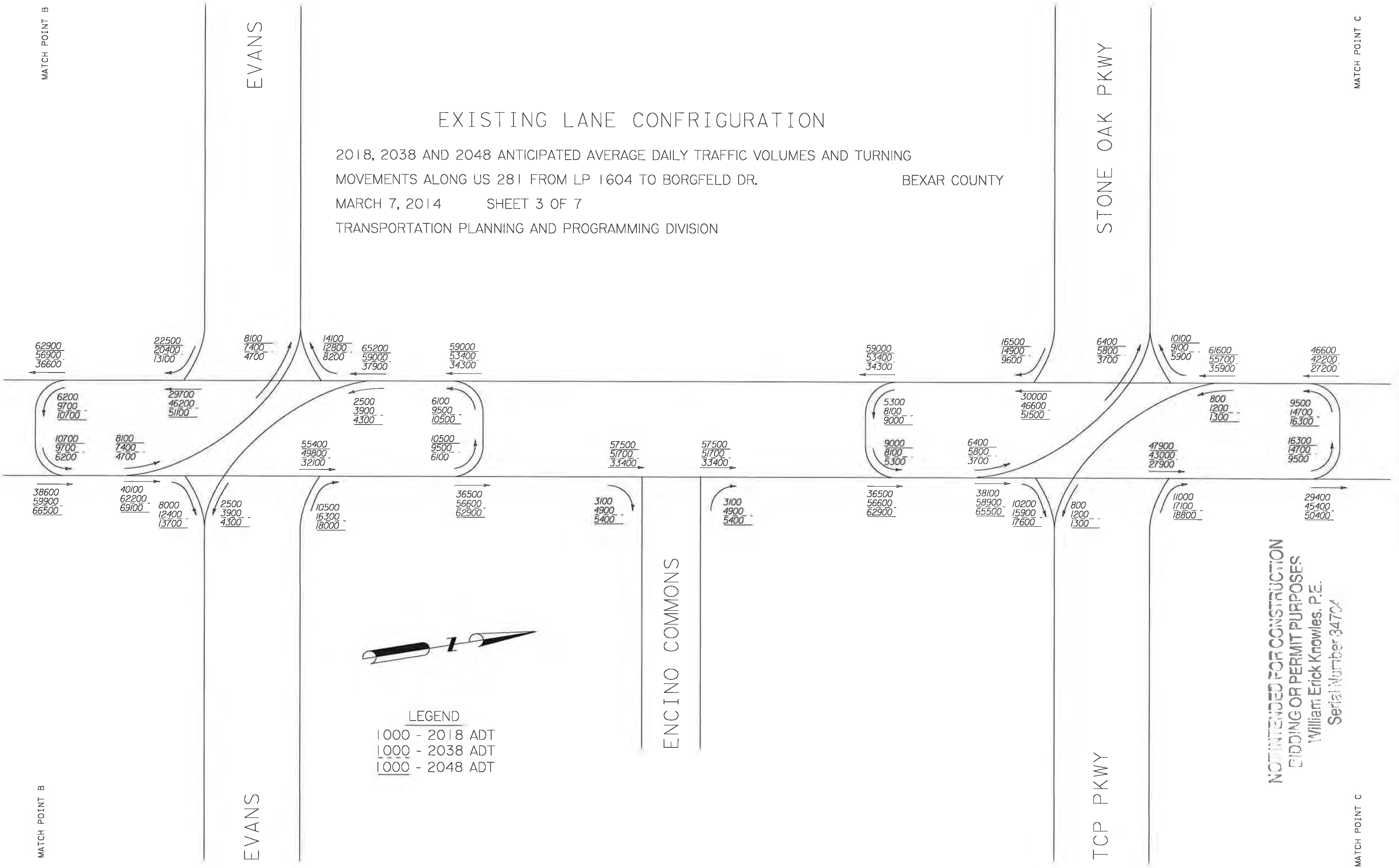
MATCH POINT B

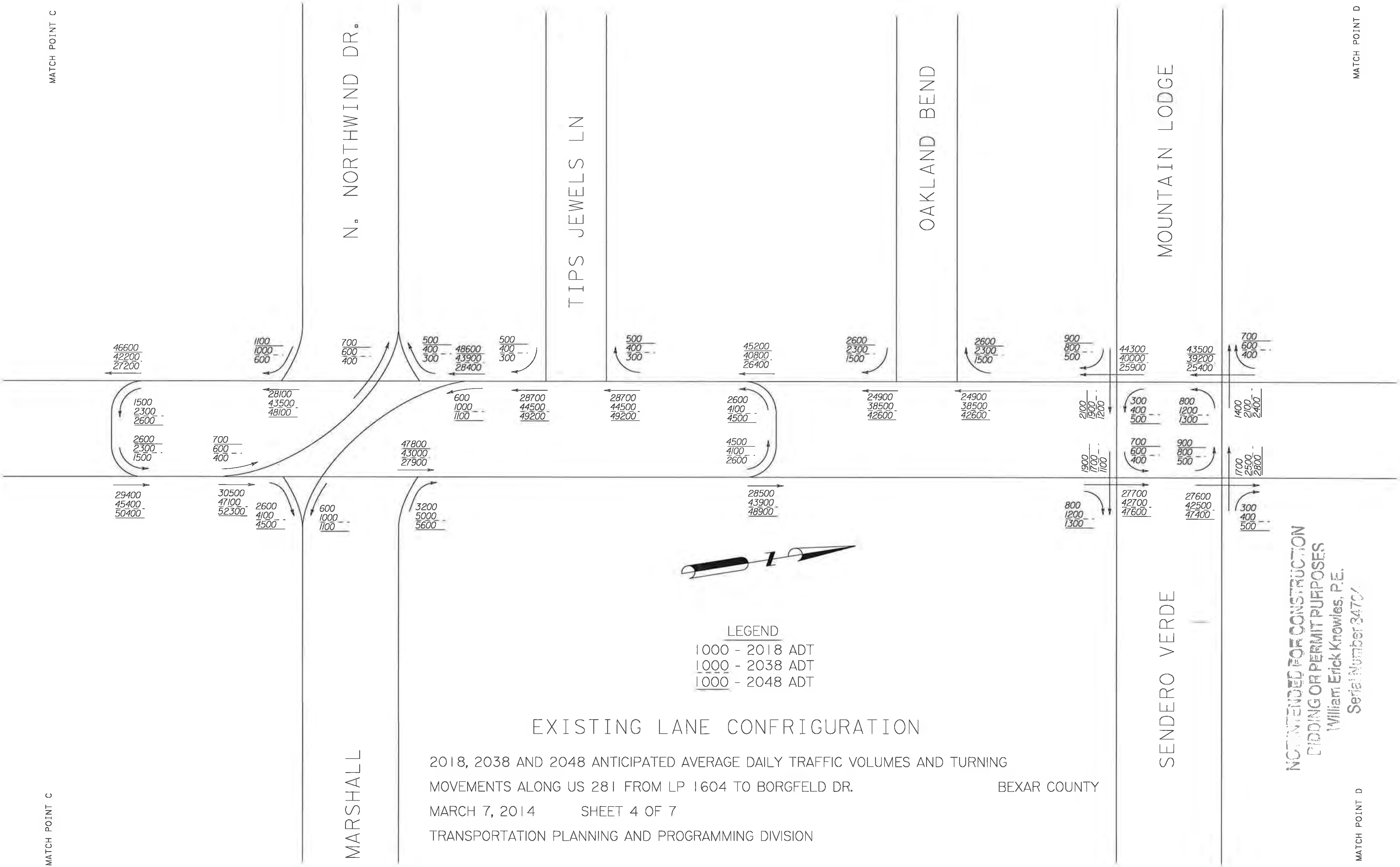
EXISTING LANE CONFRIGURATION

2018, 2038 AND 2048 ANTICIPATED AVERAGE DAILY TRAFFIC VOLUMES AND TURNING MOVEMENTS ALONG US 281 FROM LP 1604 TO BORGFELD DR. BEXAR COUNTY

MARCH 7, 2014 SHEET 3 OF 7

TRANSPORTATION PLANNING AND PROGRAMMING DIVISION





LEGEND
1000 - 2018 ADT
1000 - 2038 ADT
1000 - 2048 ADT

EXISTING LANE CONFRIGURATION

2018, 2038 AND 2048 ANTICIPATED AVERAGE DAILY TRAFFIC VOLUMES AND TURNING MOVEMENTS ALONG US 281 FROM LP 1604 TO BORGFELD DR. BEXAR COUNTY

MARCH 7, 2014 SHEET 4 OF 7

TRANSPORTATION PLANNING AND PROGRAMMING DIVISION

MATCH POINT D

WILDERNESS OAKS

OVERLOOK PKWY

ESTATE GATE DR.

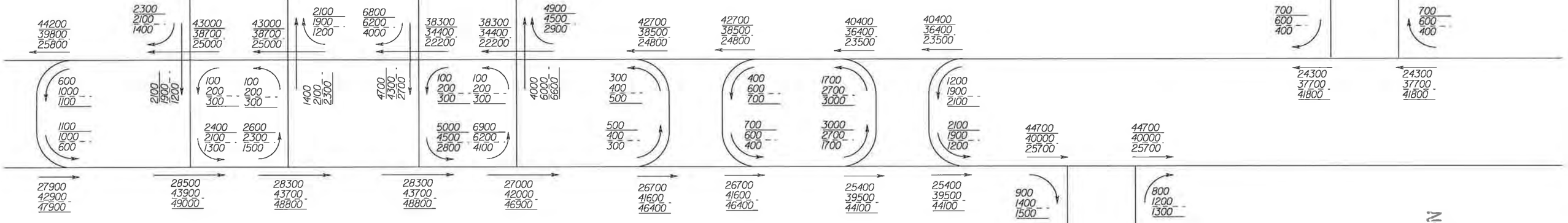
MATCH POINT E

LEGEND

1000 - 2018 ADT

1000 - 2038 ADT

1000 - 2048 ADT



WR LARSON

EXISTING LANE CONFRIGURATION

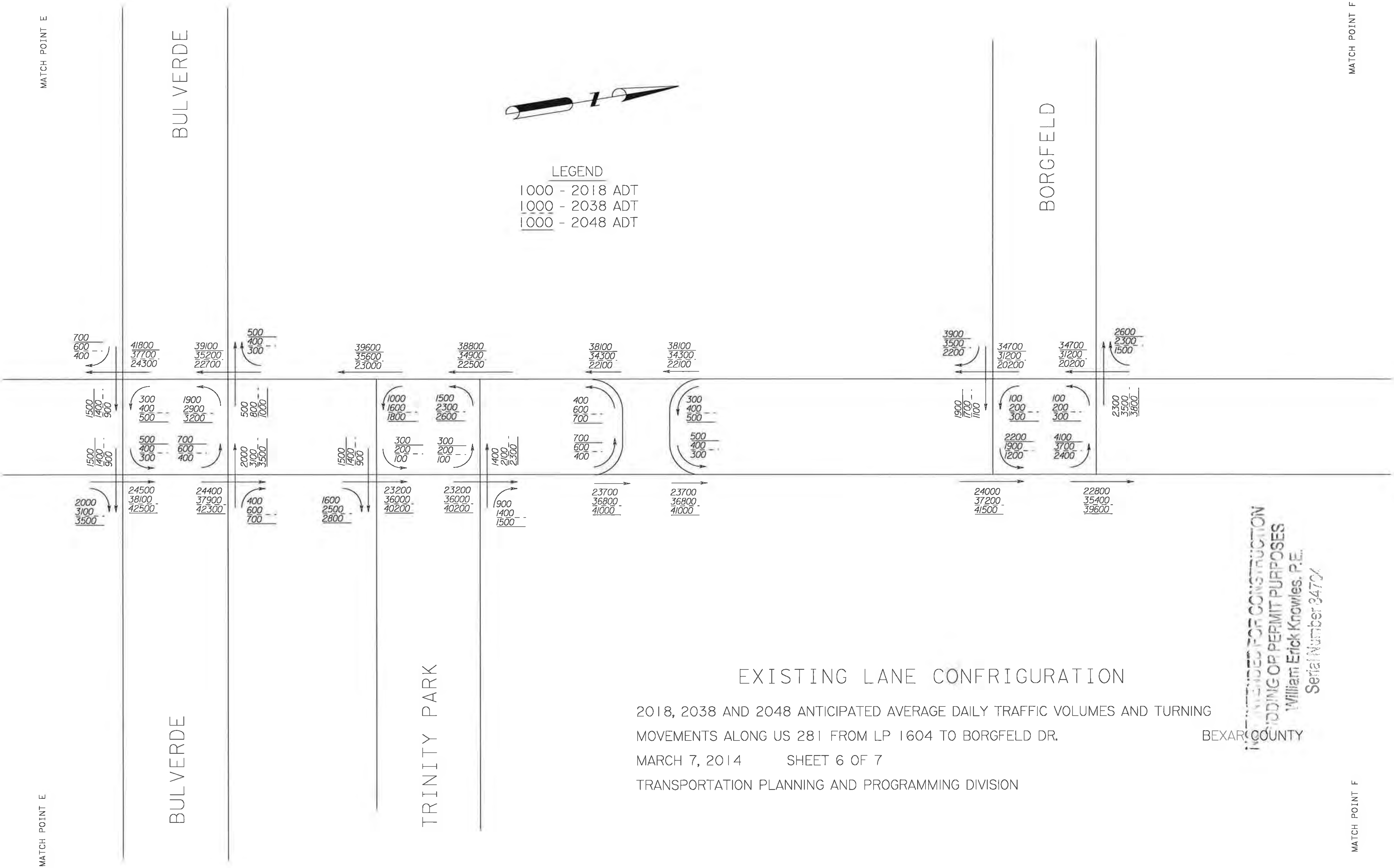
2018, 2038 AND 2048 ANTICIPATED AVERAGE DAILY TRAFFIC VOLUMES AND TURNING MOVEMENTS ALONG US 281 FROM LP 1604 TO BORGFELD DR. BEXAR COUNTY

MARCH 7, 2014 SHEET 5 OF 7

TRANSPORTATION PLANNING AND PROGRAMMING DIVISION

MATCH POINT D

MATCH POINT E



LEGEND
1000 - 2018 ADT
1000 - 2038 ADT
1000 - 2048 ADT

EXISTING LANE CONFRIGURATION

2018, 2038 AND 2048 ANTICIPATED AVERAGE DAILY TRAFFIC VOLUMES AND TURNING MOVEMENTS ALONG US 281 FROM LP 1604 TO BORGFELD DR.

BEXAR COUNTY

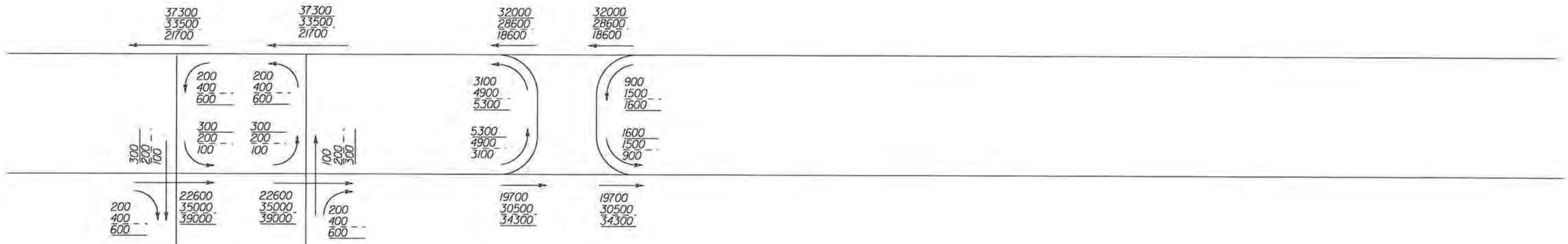
MARCH 7, 2014 SHEET 6 OF 7

TRANSPORTATION PLANNING AND PROGRAMMING DIVISION

NOT INTENDED FOR CONSTRUCTION BIDDING OR PERMIT PURPOSES
William Erick Knowles, P.E.
Serial Number 34704

MATCH POINT F

LEGEND
1000 - 2018 ADT
1000 - 2038 ADT
1000 - 2048 ADT



EXISTING LANE CONFRIGURATION

2018, 2038 AND 2048 ANTICIPATED AVERAGE DAILY TRAFFIC VOLUMES AND TURNING MOVEMENTS ALONG US 281 FROM LP 1604 TO BORGFELD DR. BEXAR COUNTY

MARCH 7, 2014 SHEET 7 OF 7

TRANSPORTATION PLANNING AND PROGRAMMING DIVISION

MATCH POINT F

LEGEND
1000 - 2018 ADT
1000 - 2038 ADT
1000 - 2048 ADT
TRANSIT LANES

LP 1604

US 281

SONTERRA BLVD

SERVICE ROAD

MATCH POINT A

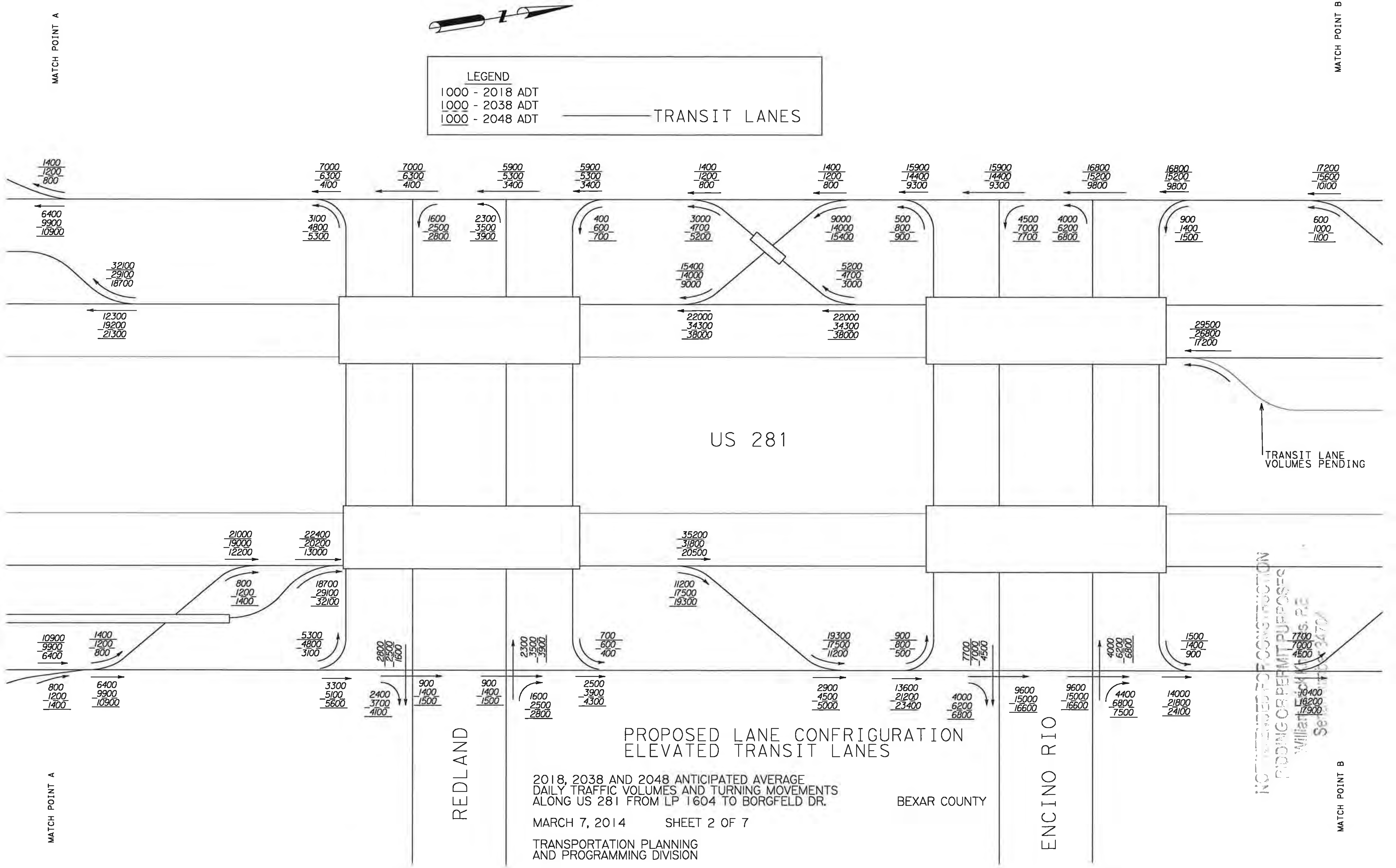
PROPOSED LANE CONFRIGURATION
ELEVATED TRANSIT LANES

2018, 2038 AND 2048 ANTICIPATED AVERAGE DAILY TRAFFIC VOLUMES AND TURNING MOVEMENTS ALONG US 281 FROM LP 1604 TO BORGFELD DR.

BEXAR COUNTY

MARCH 7, 2014 SHEET 1 OF 7

TRANSPORTATION PLANNING AND PROGRAMMING DIVISION



PROPOSED LANE CONFRIGURATION ELEVATED TRANSIT LANES

2018, 2038 AND 2048 ANTICIPATED AVERAGE DAILY TRAFFIC VOLUMES AND TURNING MOVEMENTS ALONG US 281 FROM LP 1604 TO BORGFELD DR.

BEXAR COUNTY

MARCH 7, 2014   SHEET 2 OF 7

TRANSPORTATION PLANNING AND PROGRAMMING DIVISION

MATCH POINT B

EVANS

LEGEND
1000 - 2018 ADT
1000 - 2038 ADT
1000 - 2048 ADT
——— TRANSIT LANES

PARK & RIDE

STONE OAK PKWY

MATCH POINT C

13300 12100 7800 | 8300 7600 4900 | 5000 4500 2900 | 4600 4100 2700 | 5300 4800 3100 | 9900 8900 5800 | 11000 9900 6400 | 25600 23100 14900 | 18800 16900 10900 | 7500 6800 4400 | 11300 10100 6500 | 4500 3900 2600 | 1300 1200 800 | 5800 5100 3400

2300 3500 3900 | 12600 11500 7400 | 2500 3900 4300 | 2700 4300 4700 | 9400 14400 16000 | 600 1000 1100 | 13000 20200 22300 | 4500 7000 7700 | 4000 6200 6800 | 11800 10700 6900 | 800 1200 1300 | 4700 7400 8100 | 8500 13200 14600 | 600 1000 1100

1100 1000 600 | 22300 20200 13000 | 7700 7000 4500

25000 39000 43200 | 12600 19800 22000 | 12600 19800 22000

TRANSIT LANES

35200 31800 20500 | 17200 26800 29500 | 21500 19400 12500 | 21500 19400 12500

4500 7000 7700 | 12500 19400 21400 | 5200 8100 9000

3900 3500 2300 | 11800 10700 6900 | 5100 4700 3000 | 8100 7400 4700 | 7400 11300 12600 | 1100 1000 600 | 21400 19400 12500 | 9000 8100 5200 | 6800 6200 4000 | 12000 10900 7100 | 1100 1000 600 | 6400 5800 3700 | 9500 14800 16300 | 1100 1000 600

8100 12700 14000 | 3000 4700 5100 | 5100 8000 8900 | 3400 5300 5900 | 1700 2700 3000 | 5100 8000 8900 | 5700 9000 10000 | 13000 20300 22400 | 9000 14100 15600 | 4700 7400 8100 | 4300 6700 7500 | 1200 1900 2200 | 800 1200 1300 | 2000 3100 3500

PROPOSED LANE CONFRIGURATION
ELEVATED TRANSIT LANES

2018, 2038 AND 2048 ANTICIPATED AVERAGE
DAILY TRAFFIC VOLUMES AND TURNING MOVEMENTS
ALONG US 281 FROM LP 1604 TO BORGFELD DR.

BEXAR COUNTY

MARCH 7, 2014 SHEET 3 OF 7

TRANSPORTATION PLANNING
AND PROGRAMMING DIVISION

MATCH POINT B

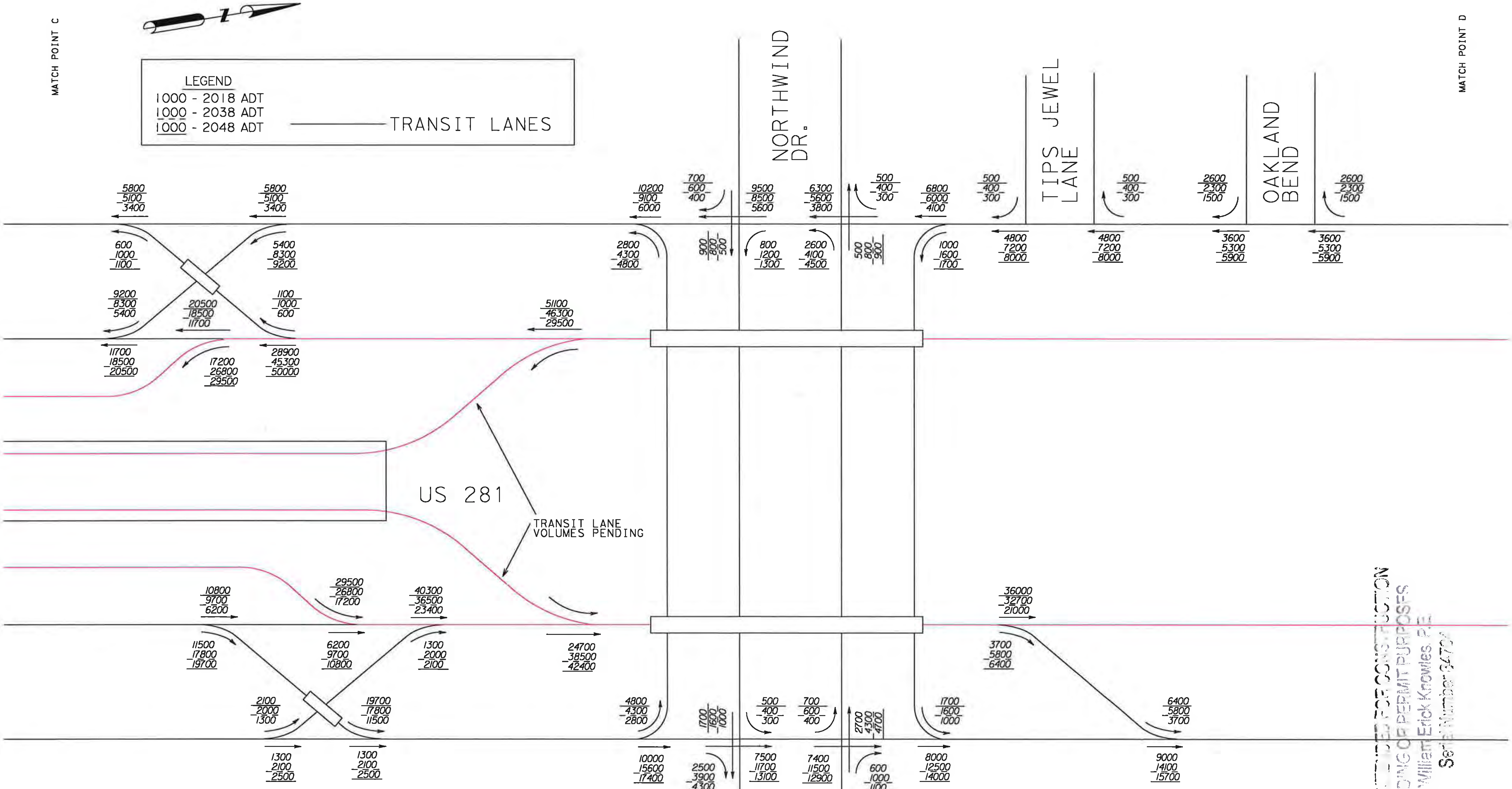
EVANS

TCP PKWY

MATCH POINT D

MATCH POINT C

MATCH POINT D



PROPOSED LANE CONFRIGURATION ELEVATED TRANSIT LANES

2018, 2038 AND 2048 ANTICIPATED AVERAGE DAILY TRAFFIC VOLUMES AND TURNING MOVEMENTS ALONG US 281 FROM LP 1604 TO BORGFELD DR.

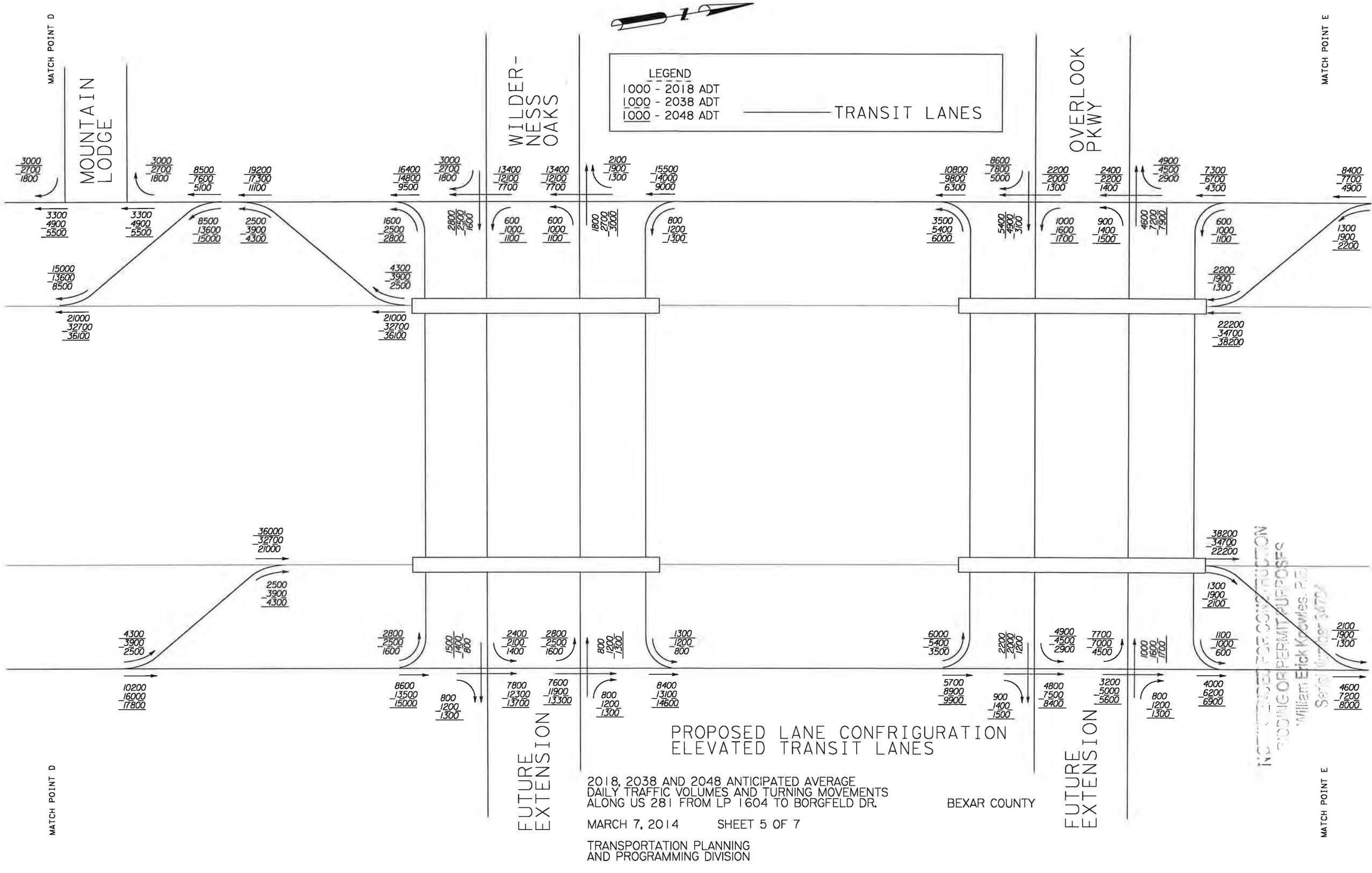
BEXAR COUNTY

MARCH 7, 2014 SHEET 4 OF 7

TRANSPORTATION PLANNING AND PROGRAMMING DIVISION

MATCH POINT C

MATCH POINT D



PROPOSED LANE CONFRIGURATION
ELEVATED TRANSIT LANES

2018, 2038 AND 2048 ANTICIPATED AVERAGE DAILY TRAFFIC VOLUMES AND TURNING MOVEMENTS ALONG US 281 FROM LP 1604 TO BORGFELD DR.

BEXAR COUNTY

MARCH 7, 2014 SHEET 5 OF 7

TRANSPORTATION PLANNING AND PROGRAMMING DIVISION

PROPOSED LANE CONFRIGURATION
ELEVATED TRANSIT LANES

2018, 2038 AND 2048 ANTICIPATED
AVERAGE DAILY TRAFFIC VOLUMES
AND TURNING MOVEMENTS ALONG
US 281 FROM LP 1604
TO BORGFELD DR. BEXAR COUNTY

MARCH 7, 2014 SHEET 6 OF 7

TRANSPORTATION PLANNING
AND PROGRAMMING DIVISION

LEGEND
1000 - 2018 ADT
1000 - 2038 ADT
1000 - 2048 ADT
TRANSIT LANES

MATCH POINT E

ESTATE GATE DR.

BULVERDE

MATCH POINT F

6300 / 5700 / 3700
2500 / 3900 / 4300
4300 / 3900 / 2500
22200 / 34700 / 38200
700 / 600 / 400
3300 / 5100 / 5600
4100 / 3700 / 2400
1300 / 2000 / 2200
1500 / 1400 / 900
3400 / 3100 / 2000
400 / 600 / 700
900 / 800 / 500
1900 / 2900 / 3200
500 / 400 / 300
1100 / 1800 / 2000
1400 / 1200 / 800
600 / 1000 / 1100
2500 / 2200 / 1400
7200 / 11300 / 12400
12400 / 11300 / 7200
17500 / 27300 / 30100

38200 / 34700 / 22200
2500 / 3900 / 4300
4300 / 3900 / 2500
3400 / 5200 / 5800
4300 / 3800 / 2500
900 / 1400 / 1500
1500 / 2300 / 2500
2200 / 2000 / 1300
2700 / 4100 / 4600
1700 / 1600 / 1000
2100 / 3100 / 3500
500 / 400 / 300
600 / 1000 / 1100
700 / 600 / 400
500 / 800 / 900
2600 / 4100 / 4500
500 / 800 / 900
1000 / 1600 / 1800
32900 / 29900 / 19100
5600 / 8700 / 9600
1100 / 1000 / 600
9600 / 8700 / 5600
1600 / 2600 / 2900
8200 / 7400 / 4700
2500 / 3900 / 4300
8200 / 7400 / 4700
2300 / 3500 / 3900

WR LARSON

BULVERDE

TRINITY PARK

MATCH POINT E

MATCH POINT F

MATCH POINT F

BORGFELD

LEGEND
1000 - 2018 ADT
1000 - 2038 ADT
1000 - 2048 ADT
TRANSIT LANES

12800 / 11600 / 7400
1200 / 1900 / 2100
2100 / 1900 / 1200
17500 / 27300 / 30100
10600 / 9600 / 6100
1300 / 2000 / 2200
5000 / 4500 / 2900
2600 / 2300 / 1500
5600 / 5100 / 3200
300 / 400 / 500
900 / 800 / 500
3000 / 4700 / 5200
2600 / 2300 / 1500
3200 / 4900 / 5600
3500 / 3100 / 2000
1300 / 1900 / 2100
5600 / 5000 / 3300
18700 / 29200 / 32200

32900 / 29900 / 19100
1300 / 1900 / 2100
2100 / 1900 / 1300
5700 / 9000 / 10000
2200 / 2000 / 1300
4400 / 7000 / 7800
3100 / 2700 / 1800
4400 / 7000 / 7800
5400 / 4800 / 3100
3100 / 4800 / 5400
3100 / 4900 / 5500
2100 / 1900 / 1300
3100 / 4900 / 5500
3200 / 2900 / 1900
2500 / 3900 / 4400
3100 / 2700 / 1700
3100 / 2700 / 1700
1400 / 2100 / 2300
800 / 1200 / 1300
35000 / 31800 / 20400
1900 / 2900 / 3200

RAMBLE-WOOD ST.

PROPOSED LANE CONFRIGURATION ELEVATED TRANSIT LANES

2018, 2038 AND 2048 ANTICIPATED AVERAGE DAILY TRAFFIC VOLUMES AND TURNING MOVEMENTS ALONG US 281 FROM LP 1604 TO BORGFELD DR.

BEXAR COUNTY

MARCH 7, 2014 SHEET 7 OF 7

TRANSPORTATION PLANNING AND PROGRAMMING DIVISION

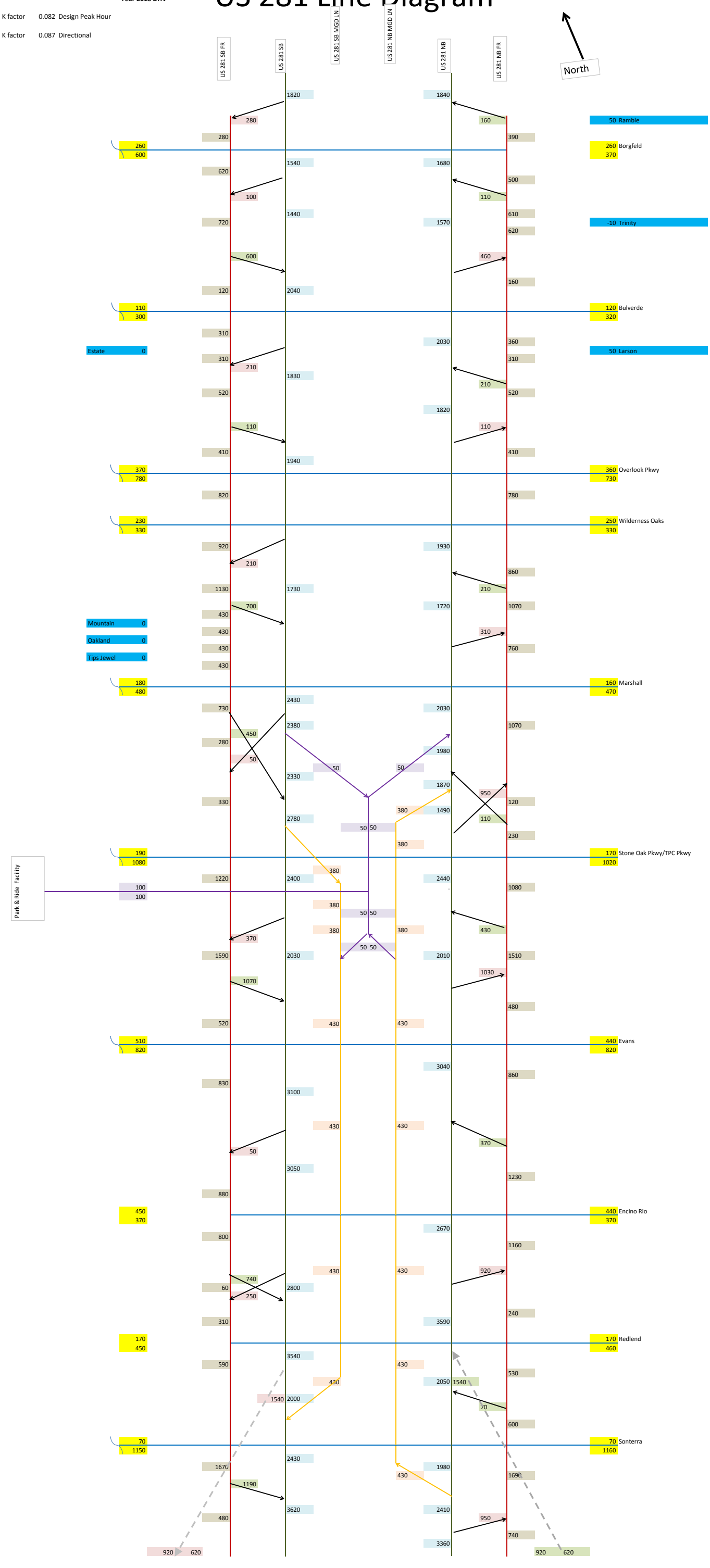
MATCH POINT F

US 281 Line Diagram

Year 2018 DHV

K factor 0.082 Design Peak Hour

K factor 0.087 Directional

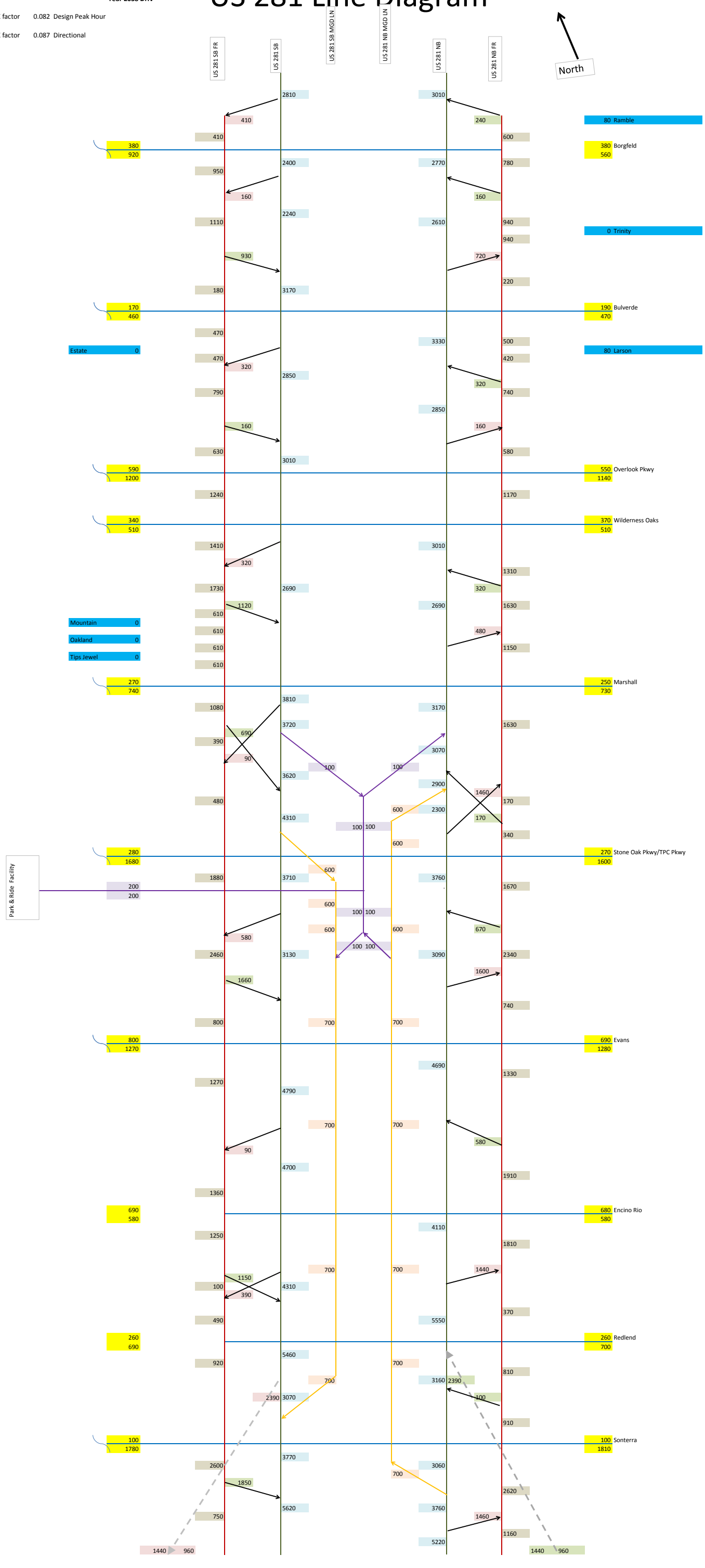


US 281 Line Diagram

Year 2038 DHV

K factor 0.082 Design Peak Hour

K factor 0.087 Directional



K factor 0.082 Design Peak Hour

US 281 Intersection Volumes

	US 281 AT REDLAND															
	SB FR INTERSETION							NB FR INTERSETION								
	SB			EB		WB		NB			EB		WB		SB-NB U-TURN	NB-SB U-TURN
	LT	THRU	RT	THRU	RT	LT	THRU	LT	THRU	RT	LT	THRU	THRU	RT		
2018 ADT	1600	1800	0	0	0	2300	0	0	900	2400	0	1600	2300	1600	400	3100
2018 DHV	140	150	0	0	0	190	0	0	80	200	0	140	190	140	40	260
2038 ADT	2500	2800	0	0	0	3500	0	0	1400	3700	0	2500	3500	2500	600	4800
2038 DHV	210	230	0	0	0	290	0	0	120	310	0	210	290	210	50	400

	US 281 AT ENCINO RIO															
	SB FR INTERSETION							NB FR INTERSETION								
	SB			EB		WB		NB			EB		WB		SB-NB U-TURN	NB-SB U-TURN
	LT	THRU	RT	THRU	RT	LT	THRU	LT	THRU	RT	LT	THRU	THRU	RT		
2018 ADT	4500	5300	0	0	0	4000	0	0	9600	4000	0	4500	4000	4400	900	500
2018 DHV	370	440	0	0	0	330	0	0	790	330	0	370	330	370	80	50
2038 ADT	7000	8200	0	0	0	6200	0	0	15000	6200	0	7000	6200	6800	1400	800
2038 DHV	580	680	0	0	0	510	0	0	1230	510	0	580	510	560	120	70

	US 281 AT EVANS															
	SB FR INTERSETION							NB FR INTERSETION								
	SB			EB		WB		NB			EB		WB		SB-NB U-TURN	NB-SB U-TURN
	LT	THRU	RT	THRU	RT	LT	THRU	LT	THRU	RT	LT	THRU	THRU	RT		
2018 ADT	2500	200	3100	7400	4900	2700	9400	4700	400	3000	3000	6900	7400	1700	600	2300
2018 DHV	210	20	260	610	410	230	780	390	40	250	250	570	610	140	50	190
2038 ADT	3900	200	4800	11500	7600	4300	14400	7400	600	4700	4700	10700	11300	2700	1000	3500
2038 DHV	320	20	400	950	630	360	1190	610	50	390	390	880	930	230	90	290

	US 281 AT STONE OAK PKWY/TPC PKWY															
	SB FR INTERSETION							NB FR INTERSETION								
	SB			EB		WB		NB			EB		WB		SB-NB U-TURN	NB-SB U-TURN
	LT	THRU	RT	THRU	RT	LT	THRU	LT	THRU	RT	LT	THRU	THRU	RT		
2018 ADT	800	1800	800	6900	4400	4700	8500	3700	600	4700	600	7100	9500	800	600	4000
2018 DHV	70	150	70	570	370	390	700	310	50	390	50	590	780	70	50	330
2038 ADT	1200	2700	1200	10700	6800	7400	13200	5800	900	7400	1000	10900	14800	1200	1000	6200
2038 DHV	100	230	100	880	560	610	1090	480	80	610	90	900	1220	100	90	510

	US 281 AT NORTHWIND/MARSHALL															
	SB FR INTERSETION							NB FR INTERSETION								
	SB			EB		WB		NB			EB		WB		SB-NB U-TURN	NB-SB U-TURN
	LT	THRU	RT	THRU	RT	LT	THRU	LT	THRU	RT	LT	THRU	THRU	RT		
2018 ADT	800	3000	300	500	400	2600	500	400	7100	2500	300	1000	2700	600	1000	2800
2018 DHV	70	250	30	50	40	220	50	40	590	210	30	90	230	50	90	230
2038 ADT	1200	4400	400	800	600	4100	800	600	11100	3900	400	1600	4300	1000	1600	4300
2038 DHV	100	370	40	70	50	340	70	50	920	320	40	140	360	90	140	360

	US 281 AT WILDERNESS/FUTURE															
	SB FR INTERSETION							NB FR INTERSETION								
	SB			EB		WB		NB			EB		WB		SB-NB U-TURN	NB-SB U-TURN
	LT	THRU	RT	THRU	RT	LT	THRU	LT	THRU	RT	LT	THRU	THRU	RT		
2018 ADT	600	7100	1300	1600	1800	600	1800	1600	6200	800	1400	800	800	800	800	1600
2018 DHV	50	590	110	140	150	50	150	140	510	70	120	70	70	70	70	140
2038 ADT	1000	11100	1900	2500	2700	1000	2700	2500	9800	1200	2100	1400	1200	1200	1200	2500
2038 DHV	90	920	160	210	230	90	230	210	810	100	180	120	100	100	100	210

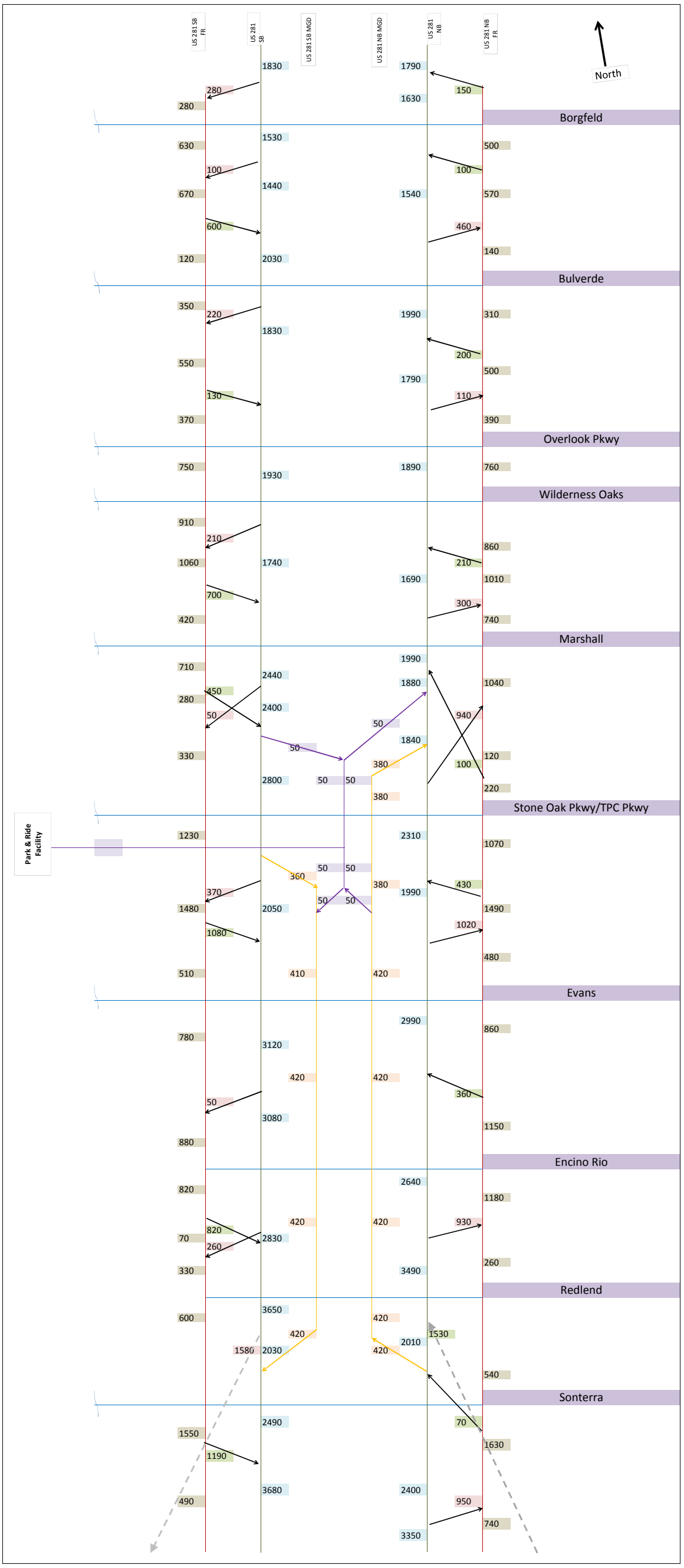
	US 281 AT OVERLOOK/FUTURE															
	SB FR INTERSETION							NB FR INTERSETION								
	SB			EB		WB		NB			EB		WB		SB-NB U-TURN	NB-SB U-TURN
	LT	THRU	RT	THRU	RT	LT	THRU	LT	THRU	RT	LT	THRU	THRU	RT		
2018 ADT	1000	400	2900	3100	5000	900	4600	4500	300	900	2900	1200	1000	800	600	3500
2018 DHV	90	40	240	260	410	80	380	370	30	80	240	100	90	70	50	290
2038 ADT	1600	600	4500	4900	7800	1400	7200	7000	500	1400	4500	2000	1600	1200	1000	5400
2038 DHV	140	50	370	410	640	120	600	580	50	120	370	170	140	100	90	450

	US 281 AT BULVERDE															
	SB FR INTERSETION							NB FR INTERSETION								
	SB			EB		WB		NB			EB		WB		SB-NB U-TURN	NB-SB U-TURN
	LT	THRU	RT	THRU	RT	LT	THRU	LT	THRU	RT	LT	THRU	THRU	RT		
2018 ADT	400	100	300	900	400	1900	1100	400	200	2100	300	1000	2600	500	600	1300
2018 DHV	40	10	30	80	40	160	100	40	20	180	30	90	220	50	50	110
2038 ADT	600	200	400	1400	600	2900	1800	600	400	3100	400	1600	4100	800	1000	2000
2038 DHV	50	20	40	120	50	240	150	50	40	260	40	140	340	70	90	170

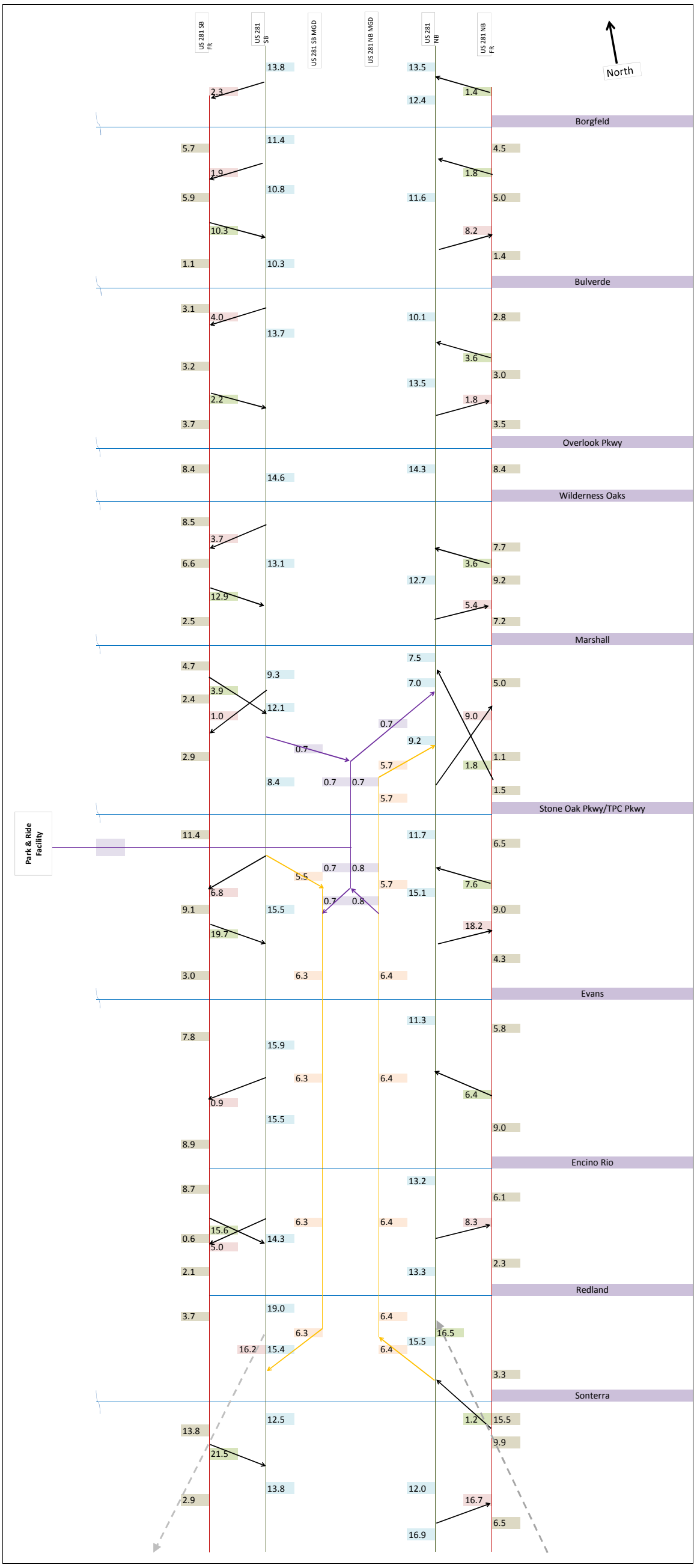
	US 281 AT BORGFELD															
	SB FR INTERSETION							NB FR INTERSETION								
	SB			EB		WB		NB			EB		WB		SB-NB U-TURN	NB-SB U-TURN
	LT	THRU	RT	THRU	RT	LT	THRU	LT	THRU	RT	LT	THRU	THRU	RT		
2018 ADT	300	200	1500	1500	2900	3000	3200	3100	1300	0	1800	0	3100	0	1300	1300
2018 DHV	30	20	130	130	240	250	270	260	110	0	150	0	260	0	110	110
2038 ADT	400	400	2300	2300	4500	4700	4900	4800	2200	0	2700	0	4800	0	1900	2000
2038 DHV	40	40	190	190	370	390	410	400	190	0	230	0	400	0	160	170

	US 281 AT BORGFELD (modified due to backage road lane configuration different than TPP)															
	SB FR INTERSETION							NB FR INTERSETION								
	SB			EB		WB		NB			EB		WB		SB-NB U-TURN	NB-SB U-TURN
	LT	THRU	RT	THRU	RT	LT	THRU	LT	THRU	RT	LT	THRU	THRU	RT		
2018 DHV	90	20	130	130	240	250	270	260	50	60	50	170	260	0	50	110
2038 DHV	120	40	190	190	370	390	410	400	80	110	80	230	400	0	80	170

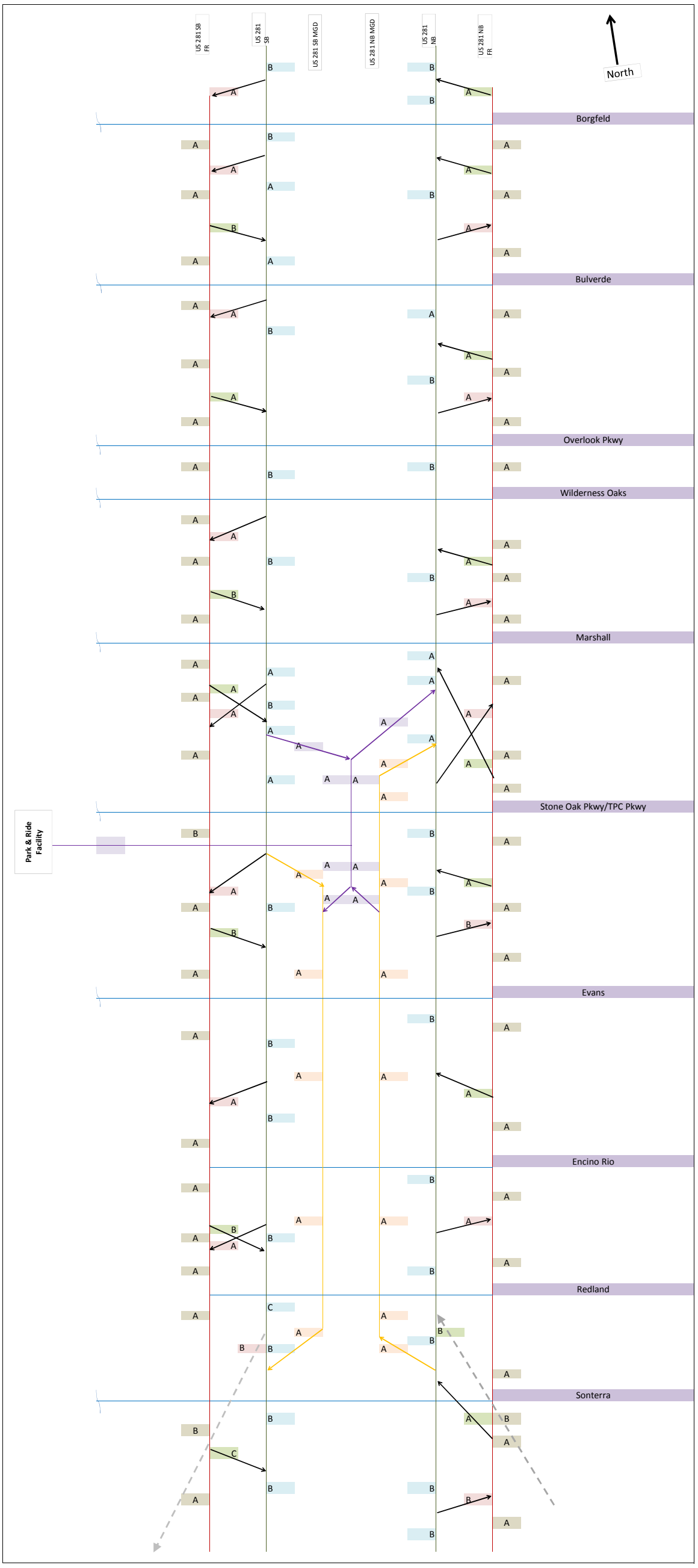
Year 2018
US 281 & Loop 1604
Processed Volumes



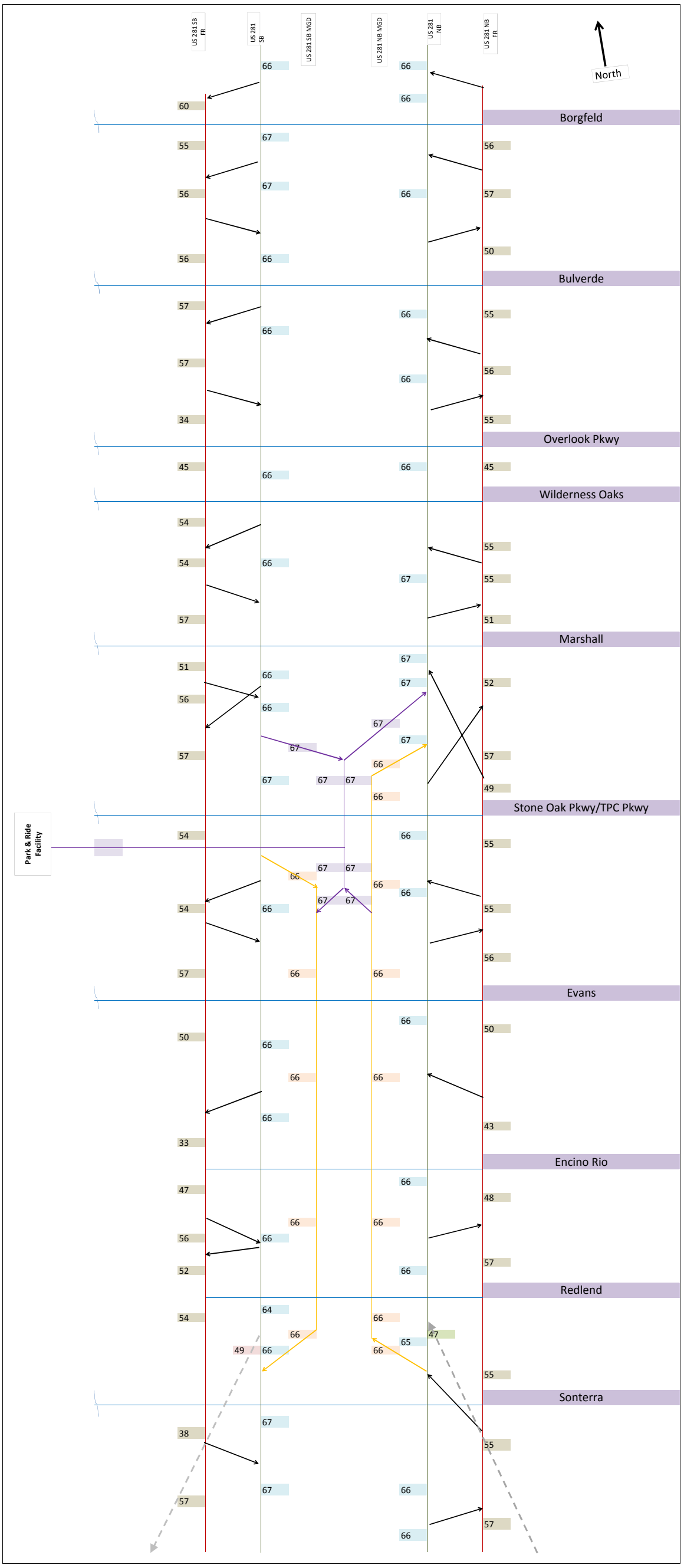
Year 2018
US 281 & Loop 1604
Density



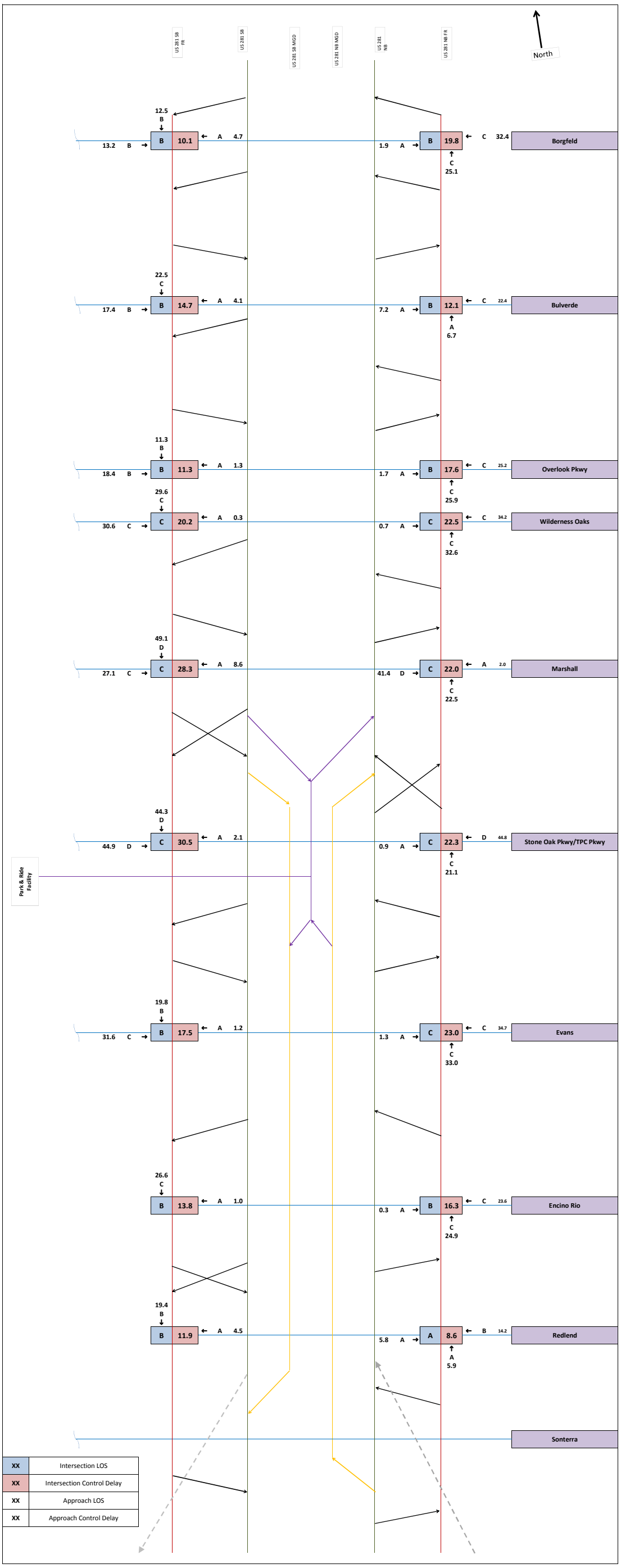
Year 2018
US 281 & Loop 1604
Link LOS



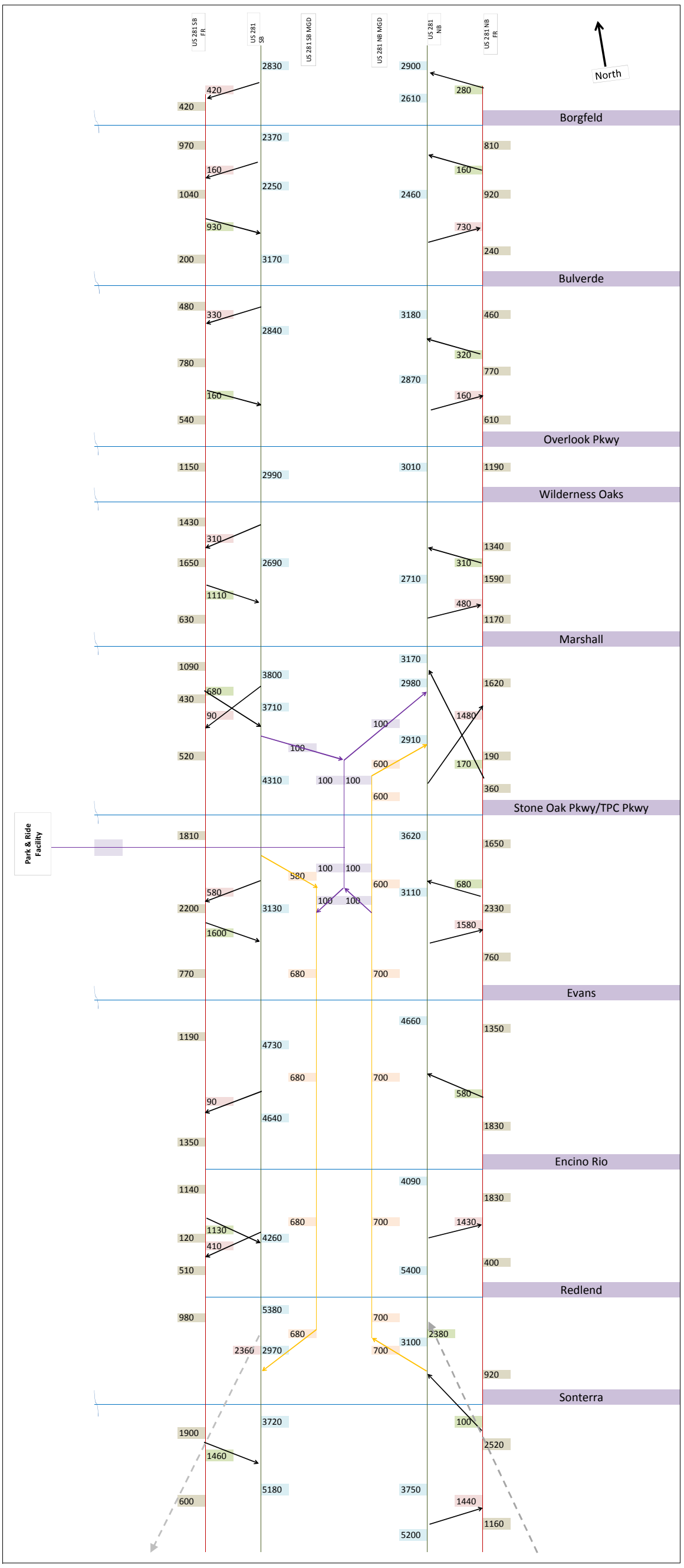
Year 2018
US 281 & Loop 1604
Speed (from VISSIM)



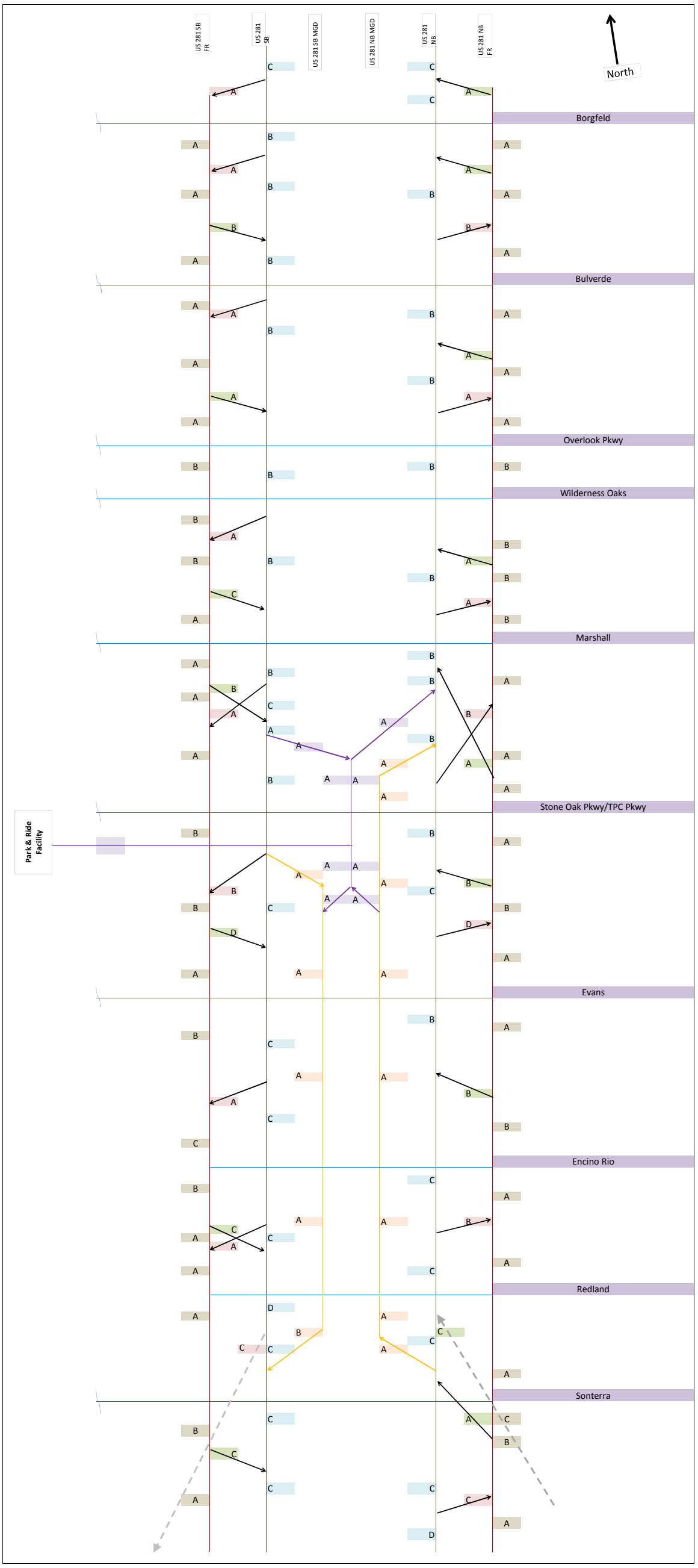
Year 2018
US 281 & Loop 1604
Control Delay/ LOS (Intersection & Approach)



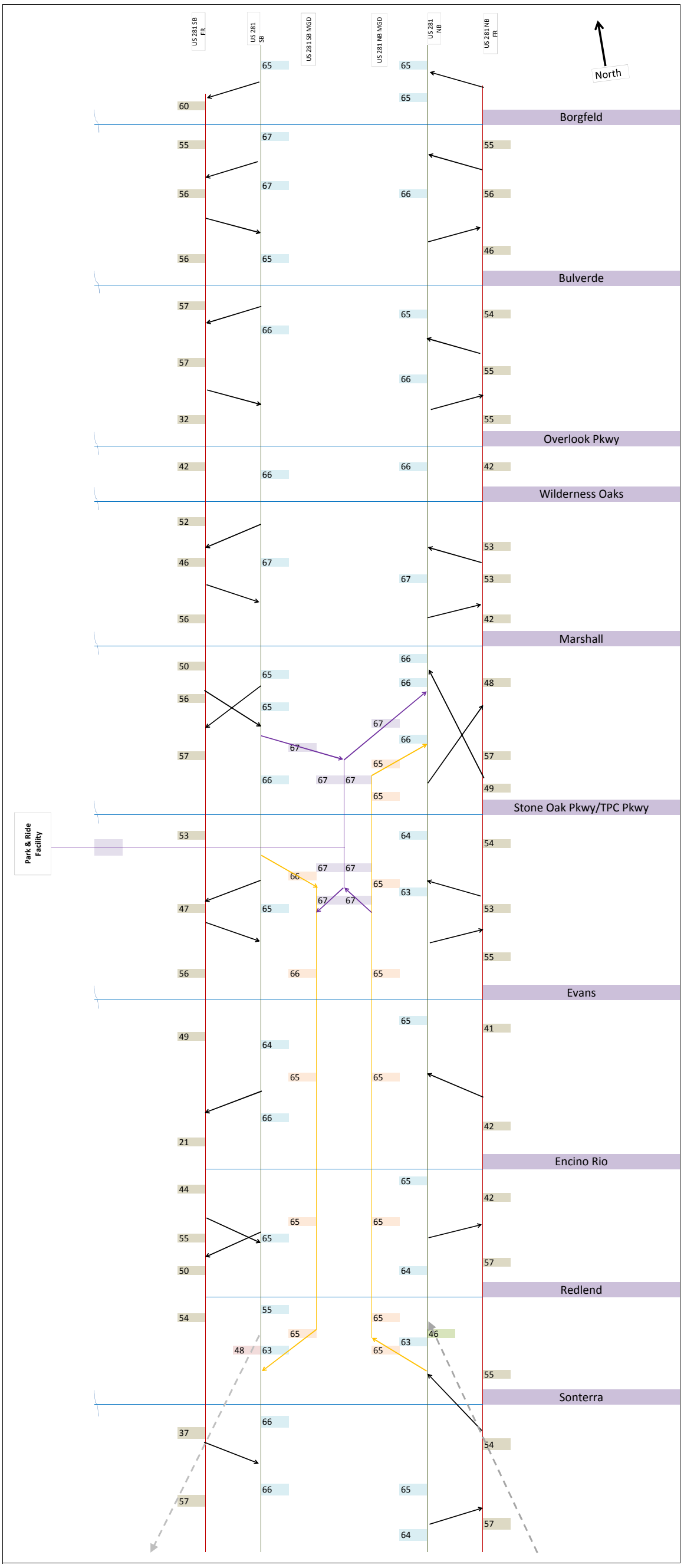
Year 2038
US 281 & Loop 1604
Processed Volumes



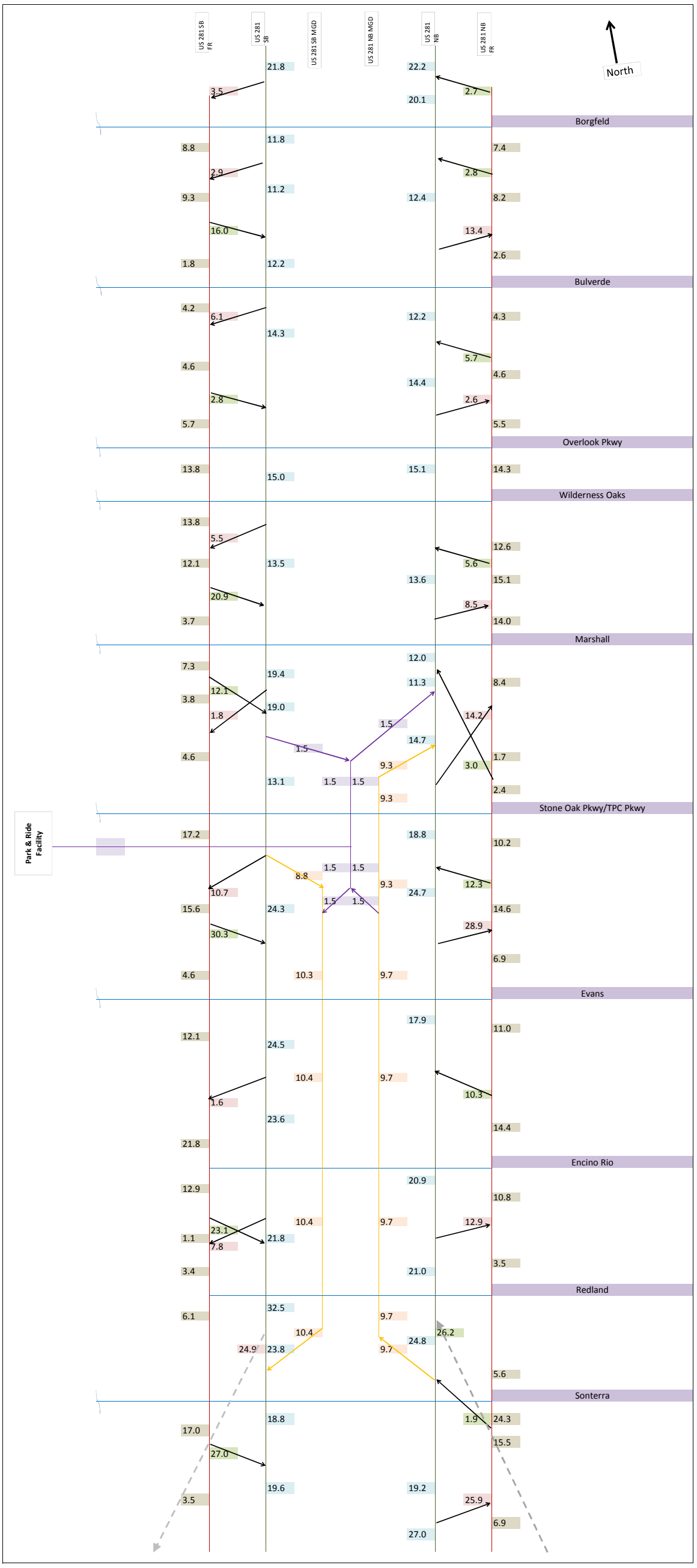
Year 2038
US 281 & Loop 1604
Link LOS



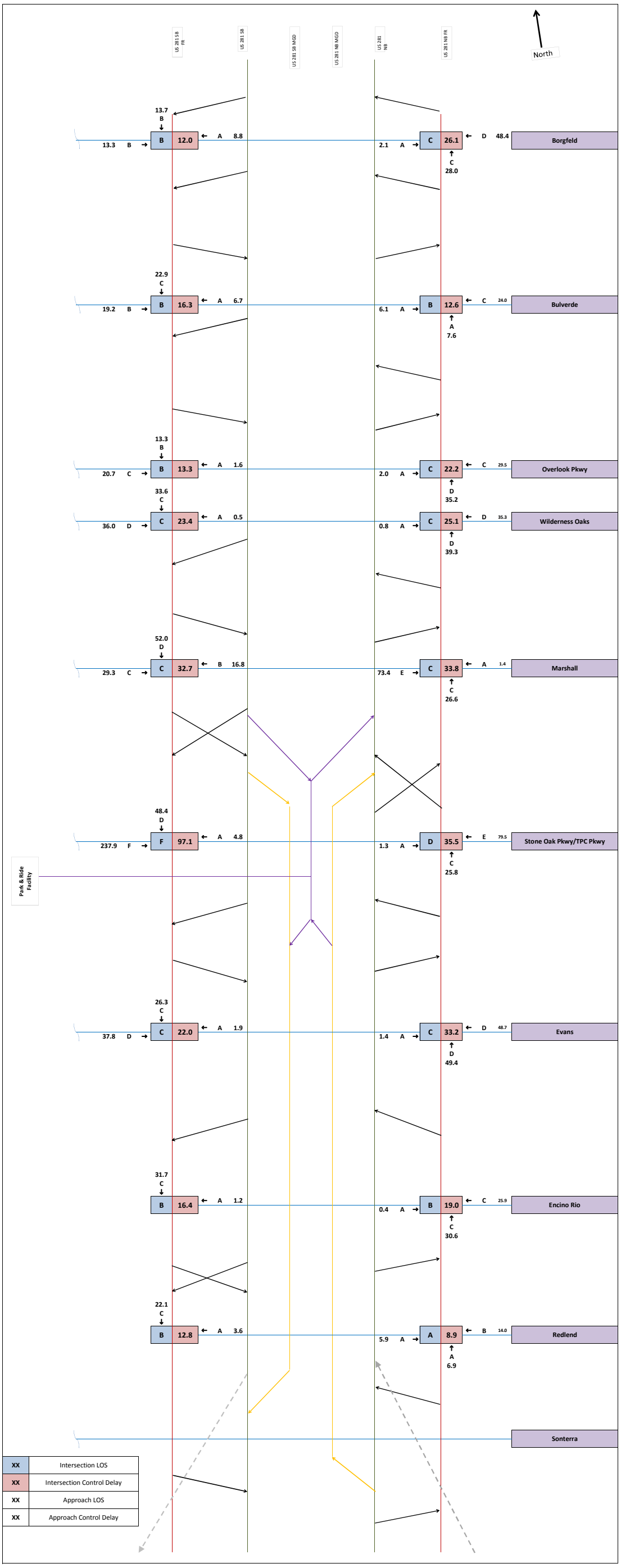
Year 2038
US 281 & Loop 1604
Speed (from VISSIM)



Year 2038
US 281 & Loop 1604
Density



Year 2038
US 281 & Loop 1604
Control Delay/ LOS (Intersection & Approach)



JACOBS

Memorandum

Jacobs Engineering Group Inc. Firm # 2966

To	Note to File
From	James A. Kratz, P.E., PTOE
Subject	VISSIM Driver Behavior Parameters

Below is information that describes the car following parameters and lane changing parameters used in both the VISSIM models (2018 & 2038) for the US 281 EIS microscopic analysis.

CAR FOLLOWING PARAMETERS

During the analysis, VISSIM uses several driver behavior parameters to reproduce vehicle following behavior, such as look ahead distance, number of observed vehicles, and etc. In addition, the Wiedemann car following model is used to model the longitudinal movement of vehicles.

VISSIM used two variations of Wiedemann model, namely: Wiedemann 99 suitable for freeway traffic operations and Wiedemann 74 suitable for arterial operations.

In the case of this project, five (5) driver behavior parameters were defined as follows:

- Merge – freeway segments including acceleration lane(s)
- Diverge – freeway segments including deceleration or drop lane(s)
- Weave – freeway segments including auxiliary lane(s) between on- and off-ramps that are less than 2,500 feet apart
- Basic Freeway – all remaining freeway segments
- Ramps/Arterials – All ramp and arterial segments

The Wiedemann 99 model was used for all (four) of the driving behaviors defined for the freeway segments, and the Wiedemann 74 model was used for the Ramps/Arterials segments

For the Wiedemann 99 model, VISSIM offers ten (10) different parameters to calibrate the car following procedure (CC0 through CC9). For the 2018 and 2038 analysis, only CC1 (Headway Time) parameters were modified in the Weaving sections. According to the VISSIM 5.4 Manual, CC1 parameters affect the desired safety distance. CC1 defines the desired following distance or headway time, which conservative driving behavior. Table 1 summarizes the Wiedemann 99 model car following parameters used in this model for the respective driving behavior sets.

Table 1 Car Following Parameters - Wiedemann 99 Model

Wiedemann 99 Model Parameters	Defaults	Basic Freeway	Merge	Diverge	Weave
CC0 (Standstill Distance) (ft)	4.92	4.92	4.92	4.92	4.92
CC1 (Headway Time) (s)	0.90	0.90	0.90	0.90	***1.00***
CC2 ('Following' Variation) (ft)	13.12	13.12	13.12	13.12	13.12
CC3 (Threshold for Entering 'Following')	-8.00	-8.00	-8.00	-8.00	-8.00
CC4 (Negative 'Following' Threshold)	-0.35	-0.35	-0.35	-0.35	-0.35
CC5 (Positive 'Following' Threshold)	0.35	0.35	0.35	0.35	0.35
CC6 (Speed dependency of Oscillation)	11.44	11.44	11.44	11.44	11.44
CC7 (Oscillation Acceleration) (ft/s^2)	0.82	0.82	0.82	0.82	0.82
CC8 (Standstill Acceleration) (ft/s^2)	11.48	11.48	11.48	11.48	11.48
CC9 (Acceleration at 50 mph) (ft/s^2)	4.92	4.92	4.92	4.92	4.92

Within the Wiedemann 74 model, average standstill distance and additive and multiplicative part of safety distance parameters can be adapted in order to achieve a performance of the defined segments as closely as possible to the observed field conditions. The additive and multiplicative parts of safety distance parameters directly affect the saturation flow rate of the relative links. Table 2 shows the Wiedemann 74 model car following parameters used in this model for the Ramps/Arterials driving behavior set. The default values for all of the parameters were used in this case.

Table 2 Car Following Parameters - Wiedemann 74 Model

Wiedemann 74 Model Parameters	Defaults	Ramps / Arterials
Average standstill distance (ft)	6.56	6.56
Additive part of safety distance (ft)	2.00	2.00
Multiplicative part of safety distance (ft)	3.00	3.00

With regard to the other car following parameters, the number of observed vehicles was the only other parameter modified. For models with a lot of friction, increasing this parameter helps to reduce the number of vehicles removed from the network due to waiting for a lane change for longer than the defined diffusion time. Vehicles are able to react sooner and increase the probability of reaching their destination, or end of the routing decision.

All remaining car following parameters are shown in Table 3.

Table 3 Car Following Parameters – Other

Other Car Following Model Parameters (Default Values)		Defaults	Urban motorized	Basic Freeway	Merge	Diverge	Weave	Ramps / Arterials
Look ahead distance	Min (ft)	0	0	0	0	0	0	0
	Max (ft)	820	820	820	820	820	820	820
	Observed vehicles	2 (W99) 2(W74)	*4*	*2*	*4*	*2*	*4*	2
Look back distance	Min (ft)	0	0	0	0	0	0	0
	Max (ft)	492	492	492	492	492	492	492
Temporary lack of attention	Duration (s)	0	0	0	0	0	0	0
	Probability (%)	0	0	0	0	0	0	0

LANE CHANGING PARAMETERS

VISSIM, just like most microsimulation software packages, accounts for two types of lane changes: necessary and discretionary. The former relates to the changes a vehicle must perform in order to reach its destination. The latter has to do with the trailing vehicle desiring to move over another lane because of lack of sufficient distance with the leading vehicle and/or the desire to travel at higher speeds. In either case an appropriate gap must exist in the destination lane for a given vehicle to make the move.

Rather than the aggressiveness of the vehicle-driver units, it is the aggressiveness of the 'lane changing' itself that can be defined in VISSIM, particularly for necessary lane changes. These parameters correspond to the default parameters of the Free Lane Selection model (or general behavior), as opposed to the Right (or Left) Side Rule model.

In order to replicate lane changing behavior along the study corridor, - 1 ft/s2 per distance (ft) rates for necessary lane changes were adjusted within the Weaving driving behavior parameter set, namely for the trailing vehicle, as well as the for the trailing vehicle.

Additionally, the Advanced Merging option, a default for lane changing driving behavior in VISSIM Version 5.4, was used for all defined driving behavior sets. This parameter was introduced to increase the cooperativeness of drivers during a necessary lane change. In addition to the Advanced Merging option, the Cooperative Lane Change option was also introduced in VISSIM Version 5.4. This feature was used for all freeway behavior sets, with adjustments made to the Maximum Speed Difference parameter as appropriate for varying degrees of cooperativeness, which results in increased friction. Lane changes occur more frequently, creating more friction, during geometric modifications in the network (Merge/Diverge/Weaving). As such, the Maximum Speed Difference parameter was increased more drastically in these freeway segments to allow for more cooperative lane changing.

Related to the emergency stop distance (defined at link level) is the "Waiting time before diffusion" parameter, which is defined globally as part of a driving behavior parameter set. When a vehicle comes to a stop at this distance because it could not change lanes to continue on its route, it will wait for a gap in traffic before being removed from the simulation. This removal occurs when the inputted 'Waiting Time Before Diffusion' is reached.

Although seemingly innocuous—or at least of marginal importance—the Waiting Time Before Diffusion parameter can seriously affect the results. A waiting time too short will produce too many vehicles to 'disappear' from the network thus the calibration targets for throughput might not be reached; while a waiting time too long might result in unrealistic congestion, particularly in a model such as this with static routing on a freeway with closely spaced interchanges. Therefore, the default value of this parameter (60 seconds) was considered to be set to a reasonable value, given the other calibration parameters defined in the model.

The Safety Distance Reduction Factor allows VISSIM to adjust the safety distance a driver maintains during a lane change. In the calibration of this model, this parameter was decreased in some of the defined behaviors in order to increase the aggressiveness of the driver when performing a lane change (especially on Weaving and Merge segments).

The default values were maintained for the remaining parameters. Table 4 shows the lane change behavior parameters used for the Study Corridor:

Table 4 Lane Change Parameters

Lane Change Parameters		Defaults	Basic Freeway	Merge	Diverge	Weave	Ramps / Arterials
Maximum deceleration	Own (ft/s^2)	-13.12	-13.12	-13.12	-13.12	-13.12	-13.12
	Trailing vehicle (ft/s^2)	-9.84	-9.84	-9.84	-9.84	-9.84	-9.84
- 1 ft/s^2 per distance (ft)	Own (ft/s^2)	200 (W99)	200	200	200	***150***	100
	Trailing vehicle (ft/s^2)	100 (W74)	200	*200*	200	***150***	100
Accepted deceleration	Own (ft/s^2)	-3.28	-3.28	-3.28	-3.28	-3.28	-3.28
	Trailing vehicle (ft/s^2)	-1.64 (W99) -3.28 (W74)	-1.64	*-1.64*	-1.64	-1.64	-3.28
Waiting time before diffusion (s)		60	60	60	60	60	60
Min. headway (front/rear) (ft)		1.64	1.64	1.64	1.64	1.64	1.64
Safety distance reduction factor		0.6	0.6	***0.4***	0.6	***0.4***	*0.6*
Maximum deceleration for cooperative braking (f		-9.84	-9.84	-9.84	-9.84	-9.84	-9.84
Overtake reduced speed areas		-	-	-	-	-	-
Advanced merging		√ [1]	√	√	√	√	√
Cooperative lane change	Maximum speed difference (mp	-	10	15	15	15	-
	Maximum collision time (s)	-	10	10	10	10	-